ED 014 424 SE 003 421

CHANGES IN ATTITUDES TOWARD SCIENCE AND CONFIDENCE IN TEACHING SCIENCE OF PROSPECTIVE ELEMENTARY TEACHERS.

BY- OSHIMA, EUGENE AKIO
OKLAHOMA STATE UNIV., STILLWATER, GRAD. SCHOOL

PUB DATE JUL 66
EDRS PRICE MF-$0.50 HC-$4.16 102P.

DESCRIPTORS- *ACADEMIC ACHIEVEMENT, *ELEMENTARY SCHOOL SCIENCE, *METHODS COURSES, *TEACHER EDUCATION, *UNDERGRADUATE STUDY, BIOLOGY, COMPARATIVE ANALYSIS, DOCTORAL THESES, EDUCATIONAL OBJECTIVES, FEMALES, INSTRUCTION, PHYSICAL SCIENCES, SCIENCE ACTIVITIES, SCIENTIFIC LITERACY, STUDENT BEHAVIOR, STUDENT TEACHING, TEACHING METHODS, TEACHER ATTITUDES, TEACHER CHARACTERISTICS, OKLAHOMA STATE UNIVERSITY, STILLWATER, OKLAHOMA,

COMPARED WERE TWO TEACHING METHODS, LECTURE-DEMONSTRATION AND INDIVIDUAL INVESTIGATION, IN TEACHING A SCIENCE METHODS COURSE FOR PROSPECTIVE ELEMENTARY SCHOOL TEACHERS. COMPARISONS WERE MADE REGARDING (1) CONFIDENCE TOWARD TEACHING SCIENCE, (2) ATTITUDES TOWARD SCIENCE, (3) ACHIEVEMENT IN SCIENCE, AND (4) STUDENT TEACHING BEHAVIORS IN SCIENCE. THE SAMPLE CONSISTED OF WOMEN STUDENTS IN THREE SECTIONS OF A SCIENCE EDUCATION COURSE AT OKLAHOMA STATE UNIVERSITY. THE STUDENTS IN THE TWO EXPERIMENTAL GROUPS PERFORMED THEIR ACTIVITIES INDIVIDUALLY. THE CONTROL GROUP, USING THE SAME ACTIVITIES IN THE SAME SEQUENCE, HAD ACTIVITIES DEMONSTRATED BY FOUR STUDENT TEAMS. ALL GROUPS WERE PRETESTED AND POST-TESTED WITH THE DUTTON SCIENCE ATTITUDE SCALE, THE EVANS CONFIDENCE SCALE, AND THE READ GENERAL SCIENCE TEST. A QUESTIONNAIRE, SUMMARY OF STUDENT TEACHING BEHAVIORS IN SCIENCE, WAS GIVEN DURING THE STUDENT TEACHING PERIOD. IT WAS CONCLUDED AT THE .05 LEVEL OF CONFIDENCE, (1) THAT THERE IS NO SIGNIFICANT DIFFERENCE IN SCORES IN (A) ATTITUDES TOWARDS SCIENCE, OR (B) SCIENCE ACHIEVEMENT, (2) THAT THERE IS NO SIGNIFICANT DIFFERENCE IN SUMMARIES OF STUDENT TEACHING BEHAVIORS, AND (3) THAT THE EXPERIMENTAL GROUPS SCORED SIGNIFICANTLY HIGHER THAN THE CONTROL IN CONFIDENCE TOWARD TEACHING SCIENCE. A PARTIAL OUTLINE OF THE COURSE ACTIVITIES USED IN THIS STUDY IS APPENDED. (DS)

ED014424

CHANGES IN ATTITUDES TOWARD SCIENCE AND CONFIDENCE IN TEACHING SCIENCE OF PROSPECTIVE ELEMENTARY TEACHERS

By

EUGENE AKIO OSHIMA

Bachelor of Arts
Colorado State College
Greeley, Colorado
1955

Master of Arts
Colorado State College
Greeley, Colorado
1956

Submitted to the faculty of the Graduate College of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
July, 1966

SE 003 421

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

CHANGES IN ATTITUDES TOWARD SCIENCE AND CONFIDENCE IN TEACHING SCIENCE OF PROSPECTIVE ELEMENTARY TEACHERS

By

EUGENE AKIO OSHIMA

Bachelor of Arts
Colorado State College
Greeley, Colorado
1955

Master of Arts
Colorado State College
Greeley, Colorado
1956

Submitted to the faculty of the Graduate College of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
July, 1966

Name: Eugene Akio Oshima Date of Degree: July, 1966

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: CHANGES IN ATTITUDES TOWARD SCIENCE AND CONFIDENCE IN TEACHING SCIENCE OF PROSPECTIVE ELEMENTARY TEACHERS

Pages in Study: 94 Candidate for Degree of Doctor of Education

Major Field: Higher Education

Scope and Method of Study: A study to compare two methods of teaching a science methods course for the prospective elementary school teacher was conducted on the Oklahoma State University campus. The study, involving three sections of Education 4K2, Science in the Elementary School Curriculum, attempted to examine the differences between the lecture-demonstration method and the individual investigation method in terms of: (1) attitudes toward science, (2) confidence toward teaching science, (3) achievement in science, and (4) student teaching behaviors in science. All three groups were pre-tested with the Dutton Science Attitude Scale, the Evans Confidence Scale, and the Read General Science Test. The students in the two experimental groups carried out their activities individually with little direction from the instructor. The control group used the same materials in the same sequence, except the activities were demonstrated by four-student teams. The materials consisted of various topics from contemporary elementary science programs which were modified to meet the objectives of the course. Each group was post-tested at the conclusion of the course. Pre-test and post-test differences were expected to indicate the effects of the difference in the method of presenting the materials. A Summary of Student Teaching Behaviors in Science questionnaire was also used to gather information concerning the behaviors of the subjects during their student teaching period.

Findings and Conclusions: The results of this study indicated that the two different methods of presenting the materials produced no significant changes in attitudes toward science. The median score remained unchanged in the control group; slight increases were recorded for the experimental groups. The control group showed no significant change in confidence in teaching science. Significant gains were found for both experimental groups. Data from the science achievement test showed no significant difference between the pre-test and post-test scores for each of the three groups. All groups showed slight increases in median scores. The Summary of Student Teaching Behaviors in Science questionnaire revealed increases in median scores but no significant changes in attitudes toward science in both control and experimental groups. The confidence scores of the experimental group were significantly higher than those of the control group.

ADVISER'S APPROVAL______________________________

CHANGES IN ATTITUDES TOWARD SCIENCE AND CONFIDENCE IN TEACHING SCIENCE OF PROSPECTIVE ELEMENTARY TEACHERS

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

PREFACE

The work reported in this investigation was performed under the graduate teaching assistantship program at the Oklahoma State University. The primary objective of this study was to compare two methods of teaching a science methods course for the prospective elementary school teacher. A related investigation, "A Study of the Effectiveness of 8mm Sound Films in the Teaching of an Elementary Science Methods Course," has recently been approved. The materials and techniques developed as a part of this thesis will provide the basic organization and tools for continuing work on these investigations.

I am especially grateful to Dr. Kenneth E. Wiggins, my supervisor and thesis adviser, for his advice and continued encouragement throughout the program of study.

I wish to thank Dr. James K. St. Clair, Head of the Education Department; Dr. Jacob W. Blankenship of the Education Department; Dr. L. Herbert Bruneau of the Zoology Department; and Dr. John E. Thomas of the Botany Department for serving on the advisory committee.

To all others who assisted directly or indirectly in this investigation, I express sincere appreciation.

TABLE OF CONTENTS

Chapter | Page

I. INTRODUCTION 1

Background of the Study 2
Statement of the Problem. 5
Hypotheses. 6
Significance of the Study 6
Limitations of the Study. 8
Clarification of Terms. 8
Basic Assumptions 9

II. ORIGIN OF THE PROBLEM AND REVIEW OF SELECTED LITERATURE. . . 11

Origin of the Problem 11
Review of Selected Literature 15

III. PERSONNEL AND EXPERIMENTAL PROCEDURES. 25

Sample Included in the Study. 25
Instruments Used in the Study 25
Collection of Data. 29
Analytical Procedures 31

IV. RESULTS OF THE STUDY 34

Attitudes Toward Science. 39
Confidence in Teaching Science. 44
Achievement in Science. 47
Summary of Student Teaching Behaviors 48
Summary of Findings 50

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS. 52

General Summary of the Investigation. 52
Summary of Results and Conclusions. 53
Recommendations 57

SELECTED BIBLIOGRAPHY 60

APPENDIX A. 65

APPENDIX B. 83

LIST OF TABLES

Table | Page

I. STEP, Attitude, Confidence, and Achievement Scores for Control Group 35

II. STEP, Attitude, Confidence, and Achievement Scores for Experimental Group I. 36

III. STEP, Attitude, Confidence, and Achievement Scores for Experimental Group II 37

IV. Attitude and Confidence Scores for Control and Experimental Groups from Summary of Student Teaching Behaviors 38

V. Responses of Prospective Elementary School Teachers Toward Science. 42

VI. Average Scale Values for Prospective Elementary School Teachers. 43

CHAPTER I

INTRODUCTION

No one doubts the fact that science has had a great impact upon our society and upon individuals as they meet the demands of our present societal structure. It seems reasonable, therefore, that in order to help individuals meet these demands, they should have the opportunity to practice science and to become scientifically literate, that is, to become familiar with some of its basic concepts. One method to accomplish this is to provide contacts with science for all students through capable science teachers in our educational systems. However, there are indications that the traditional courses in science for the prospective teacher seem too far removed from the modern concepts of science and from the special needs of elementary school teachers. This necessitates a reorientation of science education for the prospective teacher.

The need for a new approach to science teaching has been recognized by scientists and science educators for more than twenty years. A study of the 1947 yearbook of the National Society for the Study of Education (1) revealed a new movement advocating a continuous K-12 science program. This movement grew steadily until the advent of Sputnik in 1957 gave tremendous impetus to the movement. Today, many scientists and science educators agree that there should be a strong K-12 science program. As a result, elementary school science is on the threshold of a new era.

Many groups, especially the National Science Foundation, embarked on training programs for the secondary science teachers. These programs have resulted in the development of new curricula in physics, biology, chemistry, mathematics, and geology. The science background and teaching methods of many secondary science teachers have been improved through participation in summer and academic-year institutes.

During this movement, not much attention has been given to the elementary school science program. However, with the acceptance of science as an appropriate subject for the elementary school curriculum, efforts to establish a fully integrated K-12 program are underway.

Background of the Study

Many individuals, committees, and agencies have investigated the quality and quantity of science preparation received by prospective elementary school teachers. In many cases, it has been found that the preparation has been inadequate to meet present-day needs. Many science educators recommend that colleges and universities make changes to improve this phase of education. Findings by Matala (2) indicate widespread interest in the improvement of science in the elementary school level but very little work being done to solve the problems involved at the pre-service level. Mallinson (3) says that there is considerable opinion that courses designed for science majors are too specialized for elementary teachers who must teach all areas of science. She also says that there is a general belief that the typical introductory courses in science do not provide the breadth of understanding in, or develop the relationships among, the various science fields that an elementary teacher needs.

With the modern science movement shifting to the elementary school level, science educators are re-evaluating the objectives of science education. Schlessinger (4) lists the following objectives:

1. Provide experiences through which boys and girls can arrive at some of the concepts of science through observations, inquiry, problem-solving, and study of cause-and-effect relationships.
2. Provide science experiences planned around activities of significance to boys and girls.
3. Organize the learnings in science so that they will result in certain desirable outcomes by the time the child completes the elementary grades--for example, beginnings of habits of systematic observation, of quantitative thinking and representation; some acquaintance with modes of scientific thought; beginnings of a scientific vocabulary; and a desire for scientific explanations.

Smith (5), in an analysis of the viewpoints of ten prominent science educators[1] who were responsible for the production of five recent books on elementary science programs, found that they all agreed that the objectives for elementary school science--in fact, for all science education--should be stated in terms of children's behavior. They believe that the effectiveness of a science education program could be measured by the changes in certain behaviors and not in amount of knowledge accumulated.

To achieve these objectives, science curriculum groups composed of scientists, educators, and psychologists are presently developing and testing experimental units written especially for the elementary schools. These units stress new methods of problem-solving and scientific inquiry and utilize simple and inexpensive materials and equipment.

---

[1] Glenn O. Blough, Julius Schwartz, Albert J. Huggett, Paul F. Brandwein, Fletcher G. Watson, Paul E. Blackwood, Gerald S. Craig, Clark Hubler, John Navarra, and Joseph Zafforoni.

There is no question that careful planning, adequate funds, and capable leadership will be provided to develop and implement these curricular changes. However, the element that holds the key to the success of such a program is the classroom teacher. No matter how well a program is planned, implemented, funded, and equipped, the success still depends on the willingness of competent teachers to carry it through.

The elementary teacher is unique in that she must be a specialist in all academic subjects as well as a specialist in child development and all areas of classroom management. This requirement necessitates such a broad preparation that many elementary teachers believe that they are not adequately prepared, especially for science teaching (6). Victor (7) made a study of 106 elementary teachers and found the following:

1. 79.1% would rather not teach an unfamiliar subject such as science.
2. 75.8% would rather not handle unfamiliar equipment.
3. 73.6% often found it difficult to locate suitable experiments, science equipment, and supplemental reading.
4. 65.5% often found it difficult to answer some of the questions raised by pupils highly interested in science.
5. 64.0% were often disconcerted by pupils' questions about a phase of science with which they were unfamiliar.
6. 60.7% were often placed in a position of having to say, "I

don't know," when asked about a phase of science with which they were unfamiliar.

With the present emphasis on elementary school science and the development of new programs, new materials and new methods of teaching science, this feeling of inadequacy gains new significance.

Statement of the Problem

The principal objective of this study was to compare two methods of teaching a science methods course for the prospective elementary school teacher. One method involved the use of lectures, demonstrations, and student discussions of pertinent topics in the teaching of science in the elementary school. This method emphasized the telling and seeing aspects of teaching.

The second method involved identical topics but required individual investigations. Each student actively engaged in science, that is, each student actually performed the science activities to gain insight into the teaching-learning processes. This method emphasized the doing aspect of teaching.

Specifically, this study attempted to examine the differences between the lecture-demonstration group and the individual investigation group in terms of:

1. confidence toward teaching science in the elementary school
2. attitudes toward science
3. achievement in science
4. student teaching behaviors in science.

Hypotheses

The principal hypotheses tested in this study were:

1. There is no significant difference (.05 level of confidence) in scores in confidence toward teaching science of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course.
2. There is no significant difference (.05 level of confidence) in scores in attitudes toward science of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course.
3. There is no significant difference (.05 level of confidence) in scores in science achievement of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course.
4. There is no significant difference (.05 level of confidence) in summaries of student teaching behaviors in science of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course.

Significance of the Study

There has been much research in elementary school science education. Lists of principles to be taught have been compiled, units have been devised to teach these principles, and investigations have been made to determine the teachability of particular science principles at specific grade levels. Checklists, questionnaires, and other techniques have been developed and used to determine the status of the many aspects of elementary school science education. These studies include the relative stress being placed on various teaching objectives, the nature and extent of content being taught, the adequacy of teaching facilities and materials, the variety of teaching methods, and the educational background of the teachers. There have been many studies of how pupils learn, how and under what conditions concepts are most readily and effectively formed, and the conditions which will make for the most complete pupil development and which should be provided for efficient learning.

All of these findings will be of little consequence unless teacher education institutions use them in ways which will make a positive impact on prospective elementary school teachers. Changes in effective science teaching in the elementary school will come only when teachers want these changes and when they are adequately educated to carry out these changes (7, 8).

This study was undertaken to provide initial stimulus into an evaluation of the utilization of the few semester hours that are available for the adequate education of elementary teachers. If no differences are found, this study may suggest other avenues of investigation; if differences are found, this study may stimulate a search for the cause for the differences or stimulate other studies concerning the preparation of elementary school teachers and the ways in which colleges and universities can best help teachers perform more effectively.

Limitations of the Study

Certain limitations existed that may have influenced the conclusions of this study:

1. This study included only senior female elementary majors at Oklahoma State University. None of the students had had previous teaching experience and their ages varied from 20 years 4 months to 23 years 10 months.
2. Since the participation of the cooperating teachers was on a voluntary basis, a reluctance on their part to participate may have limited the testing of certain parts of the hypothesis.
3. Since the investigator taught all three groups of students, the personal bias of the investigator may have affected the results of the two procedures.

Clarification of Terms

Attitudes toward science

Attitudes toward science refers to how an individual feels about science--an emotionalized feeling for or against science as exhibited through the behavior of the individual.

Confidence toward teaching science

Confidence toward teaching science refers to how an individual feels about teaching elementary school science--a consciousness of feeling sure that she can adequately employ various learning activities as experimentation, observation, discussion, and reading.

Achievement in science

Achievement in science will mean a measure of the acquisition and retention of information in science.

Summary of student teaching behaviors in science

Summary of student teaching behaviors in science is a summary of the behaviors of student teachers as measured by means of a checklist designed by the investigator.

Cooperating teachers

Cooperating teachers are teachers who are regularly assigned to teach in a public school to whom student teachers are assigned.

Elementary school

Elementary school refers to that portion of the American school system including grades one through six.

Individual investigation group

Individual investigation group is the experimental group in which activities are conducted by individuals with little teacher direction. No formal lectures are given by the instructor.

Lecture-demonstration group

Lecture-demonstration group is the control group in which activities are demonstrated by four-student teams under the direction of the instructor. Formal lectures are given by the instructor.

Basic Assumptions

There are several assumptions that are basic to this study. It must be assumed that:

1. The instruments used in this study are valid in measuring attitudes toward science, confidence in teaching science, achievement in science, and behaviors during student teaching.
2. The many factors that influence attitudes, confidence,

achievement, and behaviors are randomized.

3. Any change in attitude toward science, confidence in teaching science, and achievement in science will be exhibited in the behavior of the student teacher during the student teaching experience.
4. The investigator can differentiate between his two teaching roles and keep the groups uncontaminated by his attitudes.

CHAPTER II

ORIGIN OF THE PROBLEM AND REVIEW OF SELECTED LITERATURE

Origin of the Problem

An examination of current literature (9, 10, 11, 12, 13, 14, 15, 16) revealed an increasing emphasis on science in the elementary schools and on the changes in science teaching. Blackwood (17), in _Science Teaching in the Elementary School, A Survey of Practices_, reports the following:

1. Except in kindergarten, science is taught over one-half year in three-fourths or more of the schools at every grade level.
2. The median number of minutes for all schools increases by grade from 45 minutes per week in kindergarten to 135 minutes in the eighth grade.
3. Science is taught by a classroom teacher without the help of an elementary science specialist in 86.5% of the schools in grades one through five, and in 72.9% of the schools in grades six through eight.
4. The two barriers to effective science teaching ranked highest for all public schools were the lack of adequate consultant service and the lack of supplies and equipment.
5. Over 65% of all schools have college-sponsored elementary science courses available to teachers.

Ploutz (18), in "Trends in the Elementary Science Curriculum," recognizes eight trends that have received the most attention and change as a result of the new emphasis on improving science teaching at the elementary level. Some of these trends are:

1. Concerning organization--materials, particularly at the fourth to sixth grade level, is designed for more "depth study."
2. Concerning individualization--greater emphasis is continually being placed on individual involvement and participation.
3. Concerning textbooks--reduction of complete dependency on the use of the conventional science textbook series.
4. Concerning equipment--trend toward individualization of instruction and greater emphasis on the use of equipment.
5. Concerning the emphasis on measurement--increased emphasis on the importance of acquiring skills in measuring and the methods of recording data.

There have been several responses to the demands for the upgrading of elementary school science and the demands for a fully integrated K-12 science program. First, numerous committees, agencies, and individuals have initiated projects to organize new programs in elementary science. The Third Report of the Information Clearinghouse in New Science and Mathematics Curricula (19), a cooperative undertaking of the American Association for the Advancement of Science and the Science Teaching Center of the University of Maryland, lists the following projects:

1. Eight major projects in elementary school science supported primarily by the National Science Foundation.
2. Eleven other major projects financed by universities,

governmental agencies, or private agencies.

3. A myriad of projects sponsored by all 50 states, Washington, D. C., and numerous local school systems.

Some of these projects have been expanded to include preliminary commercial versions. The Educational Services Incorporated materials, initially published by Houghton Mifflin Company, have been revised and are to be published by McGraw-Hill, Incorporated. The Science Curriculum Improvement Study has contracted D. C. Heath and Company to publish a commercial version of Materials Objects for controlled release to the public (20). The official announcement of the publishers of the American Association for the Advancement of Science materials is expected soon. All three programs are scheduled for limited use for the 1966 fall school term.

Second, there has been an increasing number of articles appearing in professional periodicals and magazines for elementary teachers in which problems of upgrading science and formulating an integrated K-12 program are discussed (21, 22, 23). Special science issues and supplements appear regularly describing contemporary philosophies of teaching science and contemporary science programs (24, 25, 26, 27, 28).

Third, there has been an increasing number of summer institutes and in-service science workshop programs specifically designed for elementary school personnel. A brochure published by the National Science Teachers Association (29) lists 140 summer courses, workshops, institutes, and seminars offered by colleges and universities in 41 states. A pamphlet published by the National Science Foundation (30) lists 26 summer institutes offering approximately 926 subventions, and nine cooperative projects involving 2,223 elementary school teachers and administrators. Many state departments of education and local school districts conduct their own in-service training courses through their science consultants and supervisors (31). Missouri's program is described by Leake (32); he lists objectives, outlines the program, and describes the mechanics of instituting the program. Barnard (33) recognizes this program by saying, "Until the colleges and universities redesign or overhaul their teacher education programs, there will continue to be great need for the inservice education of science teachers."

Fourth, new textbooks for the college methods course, as well as for teachers' use in the classroom, are appearing. The text by Gega (34) includes frequent use of the term "process," and in his "Introduction to Science Teaching Methods," he says:

> Most modern educators realize that for intelligent functioning it is at least as important to learn science thinking skills and attitudes (processes) as principles and facts of science (products).

Carin and Sund (35) say in the preface of their text:

> The concept of teaching science as inquiry and as methods for investigation are developed and coupled with the vast accumulation of tested ideas and principles. Evidence points clearly toward an active program of science education utilizing problem solving techniques. Procedures for the active involvement of professional scientists, blended into cooperative planning and teaching of science with children, are given as guidelines for teachers and supervisors, who recognize the need for greater structure and continuity in the science program.

They make many references to current research evidence on activity and learning processes, and to the contemporary science programs.

As these four responses or trends progress, a situation arises where there is a real danger that these investments in curriculum improvement, involving huge sums of money and talent, will be largely wasted unless adequate numbers of teachers are educated to teach effectively both the contemporary materials and those that will emerge in the future. One approach to the solution of the problem of finding capable teachers has already been mentioned--retrain teachers in-service.

Although this retraining process is invaluable, it cannot begin to meet the over-all needs. The great number of elementary school teachers and the large turnover rate present definite limitations. Also, the wide diversity of backgrounds and the fact that most teachers have been educated along widely different philosophies of teaching science from those that characterize the new programs compound the difficulty.

It is evident that the crux of the problem of providing large numbers of competent teachers to cope effectively with the rapidly evolving course materials lies in the adequate education of pre-service teachers. Thus, educators concerned with teacher preparation must face squarely the task of reforming the curricula and courses. Although reorganizing the curricula involves far more than introducing new materials and new methods of presenting them, this is a necessary first step.

Review of Selected Literature

Much has been written concerning the nature and purpose of methods courses. In some circles, educational methodology and the methods course are held in ill repute--condemned as bags of tricks without meaning or substance. Others consider them as essentials in the education of competent teachers. Rooke (36) believes that although there is no substitute for knowledge of subject matter, no person can learn how to teach until he has a good understanding of both the practical and theoretical aspects of the subject; both essentials must be understood--if only one aspect is present, the entire picture is distorted.

The plea for revisions in methods courses has been made since the 1930's. Keliher (37, 38) objects to the methods employed in teaching methods courses. She claims that in almost none do they secure any practical experiences which will equip them through actual involvement for the tasks that lie ahead; all too often the theory class promotes a theory which it does not practice.

More recently, Lee (39) lists three principles of learning which may be used as criteria by which one may evaluate methods of teaching:

1. Desired learning occurs only when the situation stimulates the learner to react in certain constructive ways.
2. Learning is largely dependent on and greatly increased by the desire of the individual to accomplish this particular learning.
3. Learning is dependent on the learner's conscious awareness of and ability to use learning skills.

Spalding (40), in "Some Thoughts About the Education of Teachers," says: "Undergraduates need to learn how to learn, to acquire attitudes and abilities which will enable them to intentionally acquire new methods and new content as knowledge of each advances."

While no method in and of itself can be characterized as wholly good or bad, unless of course, it violates the well-being of the student, the objections cited by critics of methods courses fall into three categories: the methods employed, the lack of activities designed to give confidence to the prospective teacher, and the lack of activities designed to develop positive attitudes and interest toward science teaching.

One wonders to what extent the widely used quotation, "What you do speaks so loudly I cannot hear what you say," illustrates the methods used by instructors of methods courses. Too many professors may unwittingly demonstrate a disregard for many sound teaching methods simply by never using them. Instructors may often urge their students in methods courses to use a variety of approaches while they themselves rely exclusively upon one method. Dierenfield (41) says:

> We pay too much lip service to the principles of learning and often forget that we probably teach more by example than by precept. There is enough truth in the old saying, "We teach as we were taught," to make us stop and think. To teach effectively, to change the thinking and behavior of prospective teachers toward instructional techniques, we must furnish not only the principles of teaching but an example of how to use them well.

Hoover (42), in "Teaching Methods of Teaching by Demonstration and Application," summarizes this problem by saying:

> The professor, all too frequently, tells the student that one learns by doing; relates a number of methods while using only one (the lecture); preaches teacher-pupil planning while imposing the task himself; encourages the use of situational-type test items while testing for facts; wants the prospective teacher to provide for individual differences while teaching him to evaluate on the basis of the normal curve of probability; finds himself lecturing on the reasons for not lecturing.
>
> Instead of being taught through lectures, however, the methods are "taught" through demonstrations and applications of the method under consideration. For example, the conference method is taught through the use of the conference method.

Hedges and MacDougal (43), in describing a basic dilemma in the teaching of science in the elementary school, say that since teachers frequently teach as they were taught, their methods of teaching science to children are often characterized by the monotonous presentation of subject matter to be memorized and fed back. They challenge the college methods course by asking:

> How many will testify they have been aided in college to know how to help a child "find out" and can and do resist the perennial temptation to tell-tell-tell instead of the more difficult but infinitely more rewarding task of guiding the children

to discover some things for themselves?

Scott (44), in reviewing the University of California Elementary School Science Project, says:

> It is doubtful that the philosophy of experimental science can be transmitted through verbal communication in any case. It is likely that the teachers must experience the philosophy and methods of experimentation through active participation in science, in the same manner that it is hoped children will experience these attributes in their program.

Washton (45), in a study of elementary teachers, found that:

> 1. Most elementary school teachers dislike science because they did not achieve high scores on tests in high school or college .... They felt that their elementary school teachers disliked science and so it was contagious to dislike science. As a result, they were afraid to teach science to their pupils.
>
> 2. Elementary school teachers need confidence in handling and manipulating materials that are used in scientific experiments and demonstrations. When the teachers were given such opportunities to develop these skills in the course, they acquired confidence and improved techniques.

Evans (46) found that additional opportunities to come in contact with science seem to have a direct influence in developing in-service teachers' feelings of confidence toward various kinds of learning activities (experimentation, observation, discussion, and reading) in both the biological and physical sciences.

There have been numerous studies investigating the relationships among attitudes, interests, and achievement. Paul A. Witty (47) explains the role of attitudes in children's failure and success with this statement:

> In every other subject area too the efficiency of instruction will be heightened by the development of an educational program which recognizes the significance of each child's attitudes....

Ragan's (48) statements point out the importance of attitudes in facilitating learning:

> The child's attitudes affect what he learns, what he remembers, and what he does. Hence, evaluation of the child's attitudes--his feelings for or against things--assumes a fundamental role in guiding his development.

In discussing teacher attitudes, Carin and Sund (35) make this point:

> One of the most important aspects of the problem solving approach to children's development in scientific thinking is the teacher's attitude. The teacher is the person who can make the emphasis in elementary science one of inquisitiveness and eagerness for finding answers instead of merely collecting isolated bits of facts.
>
> Another more subtle influence that the teacher has in stimulating and nurturing children's inquisitiveness is the teacher's reactions to many everyday occurrences.

Based on the thesis that in working on a task, an individual develops certain beliefs, values, and preferences specific to the task itself, Breer and Locke (49) conducted extensive studies. In their theory, the individual learns by doing, that is, by working on a task. They contend that attitudes have their roots in task experience and their theory would predict that no attitude change will take place until the individual has become actively engaged in performing his task, and that the longer he works at it (up to a point) the greater will its effect be on his attitudes. In summarizing their seven studies, they report the following:

> The overwhelming majority of the findings, from behavior through situationally specific orientations all the way to abstract beliefs, values, and preferences, confirmed the predictions made on the basis of our theory. There can be no doubt, in the laboratory, at least, that task experiences operate as an important determinant of an individual's system of attitudes. Whether or not these findings will be supported by studies conducted outside the laboratory is another matter.

A survey of the likes and dislikes of children in elementary school science by Perrodin (50) shows some interesting facts. The most frequently named activity to "The part I like best about Science is ...." was "experiments." Others listed often were "when we discover things," "finding out about things and what causes it to happen," "you get to discover something new each day." Answers to "The part I like least about Science is ...." may be echoes of criticisms of the methods used in college science classes and methods courses: "copying off the board," "just listening to something in class and not doing anything myself," "listening to the teacher read something," "the long, boring lectures," "just studying and not working together," "writing down study questions at end of chapter," "the work sheets we have to do."

In an effort to meet the demands of changes in elementary school science, groups of college teachers have met to consider the problems of preparing elementary school teachers to teach science effectively. Eiss (51), reporting on the Long Beach, California conference of the Commission on the Education of Teachers of Science of the National Science Teachers Association, lists the following basic principles:

1. Content and process in science are inseparable. Methodology should be consistent with the nature of science.
2. A sequential science program for prospective elementary teachers begins with so-called general education science courses.

Under each principle, several recommendations were made. Some of them were:

1. The process approach should be used and defined in teaching content.
2. Open-ended laboratory work should be an integral part of the instructional program.

3. Group analysis of laboratory experiences is a requisite.
4. Adequate time for planning and experimenting with new course content and teaching approaches should be scheduled in the college teachers' program.

Eiss further reports that the conferences held in Nashville, Tennessee, and Pittsburgh, Pennsylvania made similar recommendations. He goes on to say:

> Another theme that constantly recurred in many of the discussion groups was that teachers tend to teach as they were taught. It was considered unrealistic to expect a teacher who has been taught by routine lecture-demonstration methods and assigned traditional "cookbook" experiments to go into the classroom and teach science in the way that scientists and science educators now recommend. One group asked why college professors have recommended the use of open-ended experiments in the elementary and secondary schools, and yet continue to teach with outmoded techniques in their college science courses. If science is both content and process why is it not taught in this way in the college courses? If laboratory work is essential for understanding science in the elementary and secondary school, how can some colleges justify the inclusion of nonlaboratory science courses in their curriculums?

Fischler (52) summarizes the topic of science, process, and the learner with:

> Actually then, the discussion of content versus process is not "real." Content consists of the synthesis of facts and conceptual schemes developed as youngsters are assimilating their observations and their analyses. All of the new programs seem to be moving in this direction. Therefore, it seems necessary that teachers understand the nature of the scientific enterprise, the notion of inquiry, and the cognitive processes through which the learner can develop the conceptual structures which will enable him to look at the world more intelligently.

An attempt to develop first-rate courses in the sciences, especially designed for the prospective elementary teacher, is reported by Frank (53). Called the Cooperative Teacher Education Program, it involves eleven state colleges of Massachusetts and Educational Services

Incorporated. Pilot programs are being carried out during the 1965-1966 academic year. At the present time, most of the innovations utilize materials developed by Educational Services Incorporated.

A review of selected literature showed that there is widespread belief that teachers tend to teach as they have been taught. The teacher's ability to use the methods of science and his acquisition of science attitudes are not obtained by reading about them. They are acquired only through doing science, and thus engaging in scientific activities (5, 42, 44, 54). If prospective teachers are taught in this way, there may be an improvement effected in science teaching.

Frank (53), in discussing new methods of educating prospective elementary school teachers, says:

> Not only is it most efficient to introduce the prospective teacher to new materials and educational patterns while he or she is still a student but, since people often teach in the same way they themselves have been taught, this early introduction to the newly devised schemes of communication and learning aids, together with the underlying rationale of curriculum reform, is truly essential.

In "Science Teaching is Becoming Literate!" Karplus and Thier (55) discuss the hierarchical levels of involvement and the education of prospective teachers. They recognize four levels of involvement: the first and minimal level of involvement is limited to reading about or being told about science; the second level includes teacher-pupil and pupil-pupil discussions about science; the pupil is involved on a third level when the teacher or another pupil conducts a demonstration; on the fourth level, the individual pupil confronts the object and systems he is studying, thus learns and experiences science first hand, rather than vicariously. In preparing teachers who will be able to teach effectively on all four levels of involvement, they recommend placing major emphasis on the role of the teacher in the classroom.

> This change in the teacher's view of her role in the classroom will require major changes in the whole structure of preservice and in-service teacher education in America. The real problem is not what education or science courses are taken by the prospective teacher, but instead it is the question of how these courses are conducted and organized. A prospective teacher who spends her pre-service career in situations conducted almost entirely on the first two or even the first three levels of involvement described for the pupil will not suddenly be transformed into an individual who can operate on the fourth level by the act of signing her first teaching contract.

In discussing the methods course, Rising (8), in "Recommendations for the Preparation of Elementary Teachers in Science," says:

> In this class students should carry out themselves just as many of the activities they will later ask their children to perform as time and course organization allow. This should include answering the textbook questions, trying the experiments, yes even playing the games .... Hopefully this study will be directed at materials of one or more of the contemporary programs.

Most of the reasons given to explain the reluctance of many elementary school teachers to teach science have been made without much research. A review of the literature revealed a study made by Victor (7) in which he found that teachers were afraid to teach science because of unfamiliarity of the subject and equipment. They lacked confidence in handling the equipment, and in doing experiential and experimental activities. The results of Washton's (45) study point out the need to develop in teachers confidence in handling and manipulating materials that are used in scientific activities. When the teachers were given such opportunities to develop these skills in a course, they acquired confidence and improved technique. Preliminary analyses of the data collected for a doctoral thesis by Hines (56) at Oklahoma State University seem to verify the findings of Victor and Washton. If these findings concerning in-service teachers are applicable to prospective teachers, then providing such activities in a methods course should improve the teaching of science.

Dutton and Stephens (57) define attitudes toward science as how an individual feels about elementary school science--an emotionalized feeling for or against science. When defined in this way, it is not difficult to visualize the effects of a teacher's attitudes on his teaching behavior. If negative attitudes toward science became positive and if positive attitudes became enhanced, would these changes in attitudes be associated with greater learning by the students? If the answer is "yes," then providing such activities in a methods course should improve the teaching of science in the elementary schools.

In the review of selected literature, the investigator was not able to discover a study in which an attempt was made to determine the most effective method of presenting a methods course in science to solve the problem of providing a large number of teachers who are prepared adequately not only to teach the new science materials effectively, but also to exercise judgment in the selection of such materials and to contribute to their further development.

Dr. John I. Goodlad (58) of UCLA, in his recent report on the curriculum reform movement, emphasizes the importance of teacher education in curriculum reform projects in the following statement:

> Broad-scale implementation of current curriculum projects depends upon both the usefulness of materials produced and the in-service education of the teachers who use them. Most projects have distinguished themselves on both accounts. Continuing self-renewal of the current curriculum reform movement, however, depends upon the pre-service preparation of teachers in the new content (and accompanying pedagogy), and the education of teachers of teachers who understand and are sympathetic to the place of organized subject matter in the education of the young. Current projects have not distinguished themselves on this account.

CHAPTER III

PERSONNEL AND EXPERIMENTAL PROCEDURES

Sample Included in the Study

The sample consisted of students in three sections of Education 4K2, Science in the Elementary School Curriculum, enrolled during the Spring Semester, 1966 at Oklahoma State University. The sampling was restricted to women students since only 2.1% of the enrollment was made up of men. Ages varied from 20 years 4 months to 23 years 10 months; none had previous teaching experience. Science scores on the STEP test varied from 21 to 40. All had taken at least one high school laboratory science course, usually biology; all had at least two years of high school mathematics, usually algebra and geometry; all had at least eight semester hours of college science, usually four hours in biological sciences and four hours in physical sciences; and all students had at least six semester hours of college mathematics. All students in the study had maintained at least a 2.3 overall grade point average (4.0 = A) while enrolled in the University.

Instruments Used in the Study

Four instruments, the Dutton Science Attitude Scale (57), the Evans Confidence Scale (46), the Read General Science Test (59), and a Summary of Student Teaching Behaviors in Science were used to provide data for this study.

The science attitude scale, developed by Wilbur H. Dutton and Lois Stephens (57), uses the method of Equal-Appearing Intervals developed by L. L. Thurstone and E. J. Chave (60). Most of the statements were obtained by asking 200 prospective elementary school teachers to write short statements of their feelings about science. After selecting and editing these statements based on criteria prepared by Wang, Thurstone, Likert, and Edwards (61), scale values for each of 50 statements were determined through techniques developed by Thurstone and Chave (62). The selection of the final twenty statements were made according to: items with low Q values, distribution of scale values for the scale--1 through 11, and an equal number of favorable and unfavorable statements.

Dutton and Stephens (57), in describing their scale say:

> .... the scale may be used to study the general pattern of responses for an individual or for a class. Individual scale items show like or dislike for some particular aspect of elementary school science. By placing the scale values in front of items checked by each student and totaling the points, an average for the entire scale can be secured. The reliability of this scale, measured by the test-and-retest procedure was 0.93.

Stevens (63) reports a study made in which the original partition scale of Thurstone and Chave was duplicated:

> In 1959 Finnie and Luce undertook to apply a larger battery of scaling devices to some of the same attitude statements. When they used Thurstone's method of sorting the statements into 11 categories, the resulting partition scale correlated highly with the original partition scale of Thurstone and Chave. The passage of 30 years and the use of a new sample of subjects apparently made little difference.

The confidence scale was devised under the direction of Evans (46) for a multi-faceted evaluation of a study financed in part by the U.S.

Office of Education. The instrument was tested with eighty-four teachers, revised, and administered to 145 elementary school teachers taking part in a study evaluating the effectiveness of television programs designed to stimulate pupil interest and to educate teachers in the use of various methods of learning in science. In describing their scale, they say:

> Entitled "How Do I Feel About Teaching Science?" the questionnaire is composed of eight science learning situations, which are representative of possible situations arising in an elementary-school classroom. Four of the situations are related to content in the biological sciences and four to the content and materials associated with the physical sciences.
>
> Under each teaching situation, five learning activities are described, each of which can be placed into one of four categories: Experimentation, observation, discussion, or reading. The total of forty items is divided equally among the four types of learning activities and between the biological and physical sciences.

Although the instrument was designed for use with in-service teachers, the investigator felt that it would be applicable equally to subjects in this study since the eight learning situations are typical situations found in an elementary-school classroom and since all four types of activities are familiar to the students used in this study.

The achievement test used in the study was the Read General Science Test, Form AM and BM (59). In determining the objectives and content of the test, eleven widely used textbooks, representative state curricula and courses of study, and the Forty-sixth Yearbook of the National Society for the Study of Education (1) were utilized. The mean validity index of the test items in Form AM was .42; and in Form BM, .43. The corrected split-half reliability coefficient was .88 and the standard error of measurement was 4.6 standard score points. Forms AM and BM were comparable both in content and difficulty. In describing his test, Read (59) says:

> Comparison of the distribution of scores of the two forms for the group tested indicated that the two forms are almost directly comparable at all points along the scale, even in terms of raw scores. Thus, any differences found between results of administration of the two forms are accurate reflections of changes that have taken place from one administration to the other, within the limits of the reliability of the test, and are not consequences of any systematic differences between the forms.

Although this test was devised for secondary school students, the investigator felt that it would be applicable to subjects in this study since it included basic facts and principles in all areas of science, as well as the methods of science and applications of problem-solving situations. Also, the items were not difficult enough to create a feeling of threat. The investigator also wished to make generalizations concerning comparisons of results with other studies in which the Read test was used.

The Summary of Student Teaching Behaviors in Science was designed by the investigator to categorize the teaching behaviors of the subjects during their student teaching experience. It was assumed that the content of the methods course would influence the student teaching behaviors and that the true feelings and attitudes of the student teacher would be reflected in their classroom behaviors; however, due to the wide variation in the student teaching situations and the behaviors and attitudes of the cooperating teachers, it was anticipated that specific evaluations would be difficult.

Following the patterns developed in the confidence and attitude scales, the instrument included items in which judgments, based on the expressed behaviors of the student teachers, are made by the cooperating teachers. In the area of confidence, there were two items in each of the four categories: experimentation, observation, discussion, and reading. The cooperating teachers were then asked to judge the student teachers' feelings toward science as exhibited by their behaviors. There were six statements--three favorable toward science and three unfavorable.

Collection of Data

The three sections of Education 4K2 were taught by the investigator. The major portion of the work consisted of a series of activities in physical and biological sciences designed to give better insight into how to work in a scientific manner, how to evaluate what is read and done in science, and how to make wise decisions in solving problems. The course was designed to prepare students adequately not only to teach the contemporary science materials effectively but also to exercise judgment in the selection of such materials and to contribute to their further development. The activities were developed in 1964 by the investigator and a team of National Science Foundation Academic Year Institute participants to familiarize teachers with contemporary elementary science materials. Various topics were selected from contemporary programs and modified to meet the objectives established for the course. The revisions were based on personal experiences with the new approaches and a logical sequence of activities was formulated to develop these approaches.

These activities constituted the course content of an in-service extension course for elementary school teachers offered during 1964-65. After extensive revisions and additions by another team of Academic Year Institute participants during the summer of 1965, the course was offered to in-service elementary school teachers in Watonga, Kingfisher, Sand Springs, Pond Creek, Stillwater, and Oklahoma City, Oklahoma during 1965-66.

In two sections, the individual investigation groups, these activities were conducted individually (one by pairs) with little direction from the instructor. The fifty-four students in these sections followed the philosophy of "learning by doing." Although these activities were organized to develop concepts in sequence and open-ended, natural break-in points were selected to compare notes and to view results and procedures through the eyes of elementary teachers. The instructor took a secondary role and acted as a guide and resource person.

In the third section, the lecture-demonstration group, identical activities were used. These were introduced at the same time and in the same sequence; however, four-student teams were used to demonstrate all activities. The twenty-three students in this section assumed the role of teachers and followed the philosophy of "learning by looking and listening." Lectures were given on procedures and techniques during and after these demonstrations. The instructor took a primary role and acted as an expert in elementary science teaching.

All three sections were taught by the investigator for eight weeks prior to the student teaching experience. The individual classes met separately on Mondays and Wednesdays for a period of 75 minutes for each session. A common 50-minute session was conducted on Monday afternoons in which lecture-demonstrations of selected science topics were presented. These topics were selected by members of the groups, based presumably on the areas of weakness and least competence.

A pilot study was conducted during the previous semester primarily to evaluate the student response to the new approaches, to determine the physical needs of the new program, and to determine the time requirements. The investigator had conducted an in-service class during the previous year; however, the number of semester hours offered, the time schedule, the number and kinds of students enrolled, and the physical environment were so different that a pilot study seemed advisable.

A pre-test, using all three instruments, was given during the first week of the semester. A discussion was held to explain the primary purpose of the testing. It was mentioned that the course was revised each semester and that the testing was necessary to obtain data upon which modifications were to be based. To relieve any anxiety or feeling of threat, the students were told that the results of the testing would in no way affect their course grade. A post-test was given during the eighth week, just prior to their off-campus student teaching period.

During the fourth week of the student teaching period, each cooperating teacher was contacted and requested to complete a form summarizing the student teacher's behaviors in teaching science. The forms were returned at the conclusion of the eight-week student teaching period. Neither the student's name nor the cooperating teacher's name appeared on the questionnaire to prevent any connotation of an evaluation or any feeling of threat. Within the limits of the questionnaire and the conditions under which the data were collected, it was hoped that some generalizations could be made.

Analytical Procedures

The basic design used in this study was what Barnes (64) describes as "'Before-After' Study with Control Groups." In this method, two or more groups are given pre-tests and post-tests. Any differences between the scores are inferred to be due to the difference in treatments during the pre- and post-tests.

Since the groups were pre-tested, subject to uncontrollable factors and vulnerable to unplanned, contemporaneous events, the differences between the scores of the groups should approximate a direct indication of the independent variable's influence.

The pre-test scores of the groups were used to check the initial absence of differences among the groups. With this established, the post-test scores of the groups were compared to analyze the influence of the experimental variable. Pre-test scores and post-test scores of all groups were used to calculate changes in scores. Then comparisons were made between the changes in the experimental groups with the changes in the control group.

Using what Siegel (65) describes as "The Case of k Independent Samples," the null hypothesis that k independent samples have been drawn from the same population or from k identical populations was tested. The Kruskal-Wallis one-way analysis of variance was used. This test was applied to both STEP test science scores made by the subjects during their second semester of their sophomore year, and their pre-test scores. This procedure was used to determine any significant difference among the groups prior to the experimental treatment.

The Kruskal-Wallis test was also applied to the post-test scores. When the null hypothesis of no difference was rejected, additional tests were applied to determine the direction and the degree of the differences. The Mann-Whitney U test (65) was used in analyzing the data from the Summary of Student Teaching Behaviors in Science questionnaire since it was necessary to eliminate one of the experimental groups from this part of the study.

The second statistical procedure was the Wilcoxon matched-pairs signed-ranks test as given by Siegel (65). This test was used to determine the degree and direction of change between the pre-test and post-test.

Finally, specific items and areas were examined by the use of the Binomial test (65).

CHAPTER IV

RESULTS OF THE STUDY

As indicated previously, several types of evaluation instruments were employed in gathering information from which assessments were made of the over-all effectiveness of the two methods of teaching a science methods course for the prospective elementary school teacher. Such information, both subjective and objective in nature, came from students and their cooperating teachers. This chapter reports the data gathered and interprets these from inferences provided through the use of certain statistical procedures. The scores are tabulated in Tables I, II, III, and IV.

In the treatment of the responses obtained, one is always concerned with whether differences are significant. Nonparametric techniques of hypothesis testing were used in analyzing the raw data because they do not require assumptions of a normally distributed population or of data that are interval in nature. The methods of treating the samples and statistical procedures used are appropriately indicated.

Since it was not definitely known that the experimental and control groups were comparable, it was necessary to test the hypothesis that the groups were drawn from a common population. The Kruskal-Wallis one-way analysis of variance test as given by Siegel (65) was used on the STEP science scores and on the attitude, confidence, and achievement pre-test scores. The values for H were not found to be significant at the .05

TABLE I

STEP, ATTITUDE, CONFIDENCE, AND ACHIEVEMENT SCORES FOR CONTROL GROUP

Student	STEP (raw scores)	Attitude		Confidence		Achievement (raw scores)	
		Pre	Post	Pre	Post	Pre	Post
2A	33	7.8	7.5	3.7	4.1	50	55
2B	37	8.1	7.5	3.6	4.1	59	57
2C	40	8.2	8.7	4.3	4.0	55	61
2D	36	8.5	8.6	4.3	4.3	60	60
2E	30	7.5	8.5	4.4	4.3	50	52
2F	33	8.5	8.5	4.6	4.3	50	45
2G	38	7.6	8.3	4.5	4.6	50	58
2H	39	7.2	7.1	4.0	3.9	55	58
2I	31	8.0	8.0	3.7	3.9	50	50
2K	23	8.6	8.2	3.7	4.1	45	49
2L	35	8.2	8.5	3.1	3.8	55	59
2M	33	8.4	8.2	4.4	4.6	54	47
2N	38	7.5	8.1	4.2	4.2	48	57
2O	39	8.6	7.1	3.7	4.0	64	65
2P	34	8.5	8.6	4.0	3.9	52	49
2R	32	7.6	7.3	3.8	4.0	42	50
2S	23	7.5	8.0	4.6	4.5	51	51
2T	31	8.1	7.9	4.1	4.2	48	36
2U	36	8.5	8.2	3.6	4.1	50	50
2V	27	7.3	8.2	3.8	4.6	53	50
2W	34	8.6	8.6	3.7	3.7	59	59
2Z	33	7.6	7.3	4.2	3.8	45	51
2a	28	8.5	7.5	3.8	3.7	44	44
Median	33.9	8.2	8.2	4.0	4.1	51.6	51.8

TABLE II

STEP, ATTITUDE, CONFIDENCE, AND ACHIEVEMENT SCORES FOR EXPERIMENTAL GROUP I

Student	STEP (raw scores)	Attitude		Confidence		Achievement (raw scores)	
		Pre	Post	Pre	Post	Pre	Post
1A	33	8.5	8.6	3.4	4.3	46	50
1B	34	8.3	8.5	4.4	4.4	52	53
1D	35	7.6	7.8	3.5	3.7	50	41
1E	36	8.0	8.0	4.9	4.9	57	57
1G	33	7.7	7.4	3.8	4.7	58	55
1H	34	8.2	7.3	4.6	4.9	58	61
1I	30	7.2	7.3	3.9	4.3	51	56
1J	27	7.6	8.5	4.4	4.7	51	51
1K	28	8.6	8.4	2.5	4.0	50	57
1L	26	8.5	8.6	4.6	4.7	46	49
1M	26	7.9	8.5	4.2	4.7	48	52
1N	30	7.7	7.1	3.4	3.7	48	57
1O	27	8.4	7.9	3.3	3.8	56	52
1Q	34	8.7	8.6	3.4	3.5	60	52
1R	25	7.8	8.3	3.9	4.9	36	35
1S	*	7.1	6.6	4.5	4.4	50	49
1T	23	8.2	8.5	3.5	4.5	47	45
1U	21	7.8	8.6	3.2	3.6	40	45
1V	23	8.5	8.5	3.8	4.8	57	40
1W	31	6.9	7.6	3.9	4.4	61	61
1X	32	6.9	6.8	3.7	4.6	47	39
1Y	36	8.3	8.2	3.5	4.2	65	68
1Z	26	8.0	8.5	4.0	4.1	40	41
1a	37	8.5	8.5	3.7	4.2	71	67
1b	28	8.5	8.4	4.1	4.9	52	59
1c	34	6.9	7.9	3.8	4.3	59	58
Median	30.8	8.1	8.3	3.9	4.4	51.6	53.0

*score not available

TABLE III

STEP, ATTITUDE, CONFIDENCE, AND ACHIEVEMENT SCORES FOR EXPERIMENTAL GROUP II

Student	STEP (raw scores)	Attitude		Confidence		Achievement (raw scores)	
		Pre	Post	Pre	Post	Pre	Post
3A	*	8.2	8.7	3.9	3.5	47	49
3B	30	7.4	8.6	4.1	4.6	49	46
3C	36	8.1	8.3	4.5	4.5	49	52
3F	29	8.1	7.5	4.2	4.0	43	54
3G	25	7.5	8.5	4.4	4.2	24	31
3H	24	7.6	8.1	4.1	4.3	40	41
3I	29	7.6	7.9	3.9	4.1	46	45
3J	31	8.3	8.5	4.2	4.7	51	55
3K	25	8.3	8.6	3.8	4.4	50	49
3L	27	7.3	7.7	4.4	4.6	51	47
3N	25	6.5	6.8	4.1	3.7	42	35
3O	35	8.0	8.5	4.4	4.5	58	63
3P	23	7.0	7.9	4.6	4.7	48	48
3Q	34	8.5	7.9	3.8	4.6	56	58
3R	40	8.2	8.5	4.3	4.4	56	67
3S	20	8.3	8.5	3.5	3.7	36	42
3T	33	7.6	7.7	3.3	3.6	57	56
3U	39	7.9	8.5	4.5	4.7	58	65
3V	35	8.5	8.5	4.0	4.0	65	57
3W	27	8.6	8.2	3.9	4.6	57	49
3X	17	7.1	7.9	4.3	4.5	38	39
3Y	29	7.9	8.0	3.2	3.5	44	51
3a	40	8.4	8.0	4.4	4.7	68	70
3b	30	7.6	7.3	4.2	4.8	48	50
3c	29	8.5	8.6	3.6	3.9	46	41
3d	36	8.3	8.3	4.4	4.6	60	53
3f	31	9.0	8.2	4.2	4.6	60	63
3g	34	8.4	8.1	3.9	4.6	58	62
Median	30.3	8.2	8.3	4.1	4.5	50.0	51.0

*score not available

TABLE IV

ATTITUDE AND CONFIDENCE SCORES FOR CONTROL AND EXPERIMENTAL GROUPS FROM SUMMARY OF STUDENT TEACHING BEHAVIORS

Control Group			Experimental Group II		
Student	Attitude	Confidence	Student	Attitude	Confidence
2A	10.3	4.1	3C	8.3	3.6
2B	9.0	4.0	3F	8.3	5.0
2E	6.9	4.5	3H	8.3	4.0
2F	8.3	3.9	3J	9.0	4.5
2H	9.0	4.2	3L	6.9	4.4
2I	9.0	4.5	3N	9.0	4.8
2K	8.5	3.4	3O	8.3	4.3
2L	8.3	3.6	3P	6.6	4.0
2M	6.6	3.5	3R	9.0	4.8
2N	5.5	4.2	3T	9.0	4.8
2O	3.1	3.4	3Q	9.0	4.0
2P	6.5	4.1	3V	9.0	4.8
2R	9.0	4.0	3W	6.5	4.6
2U	8.5	3.6	3X	8.3	4.8
2W	8.3	4.7	3Y	6.9	4.6
2a	7.7	5.0	3a	8.3	4.8
			3b	5.8	5.0
Median	8.4	4.1	Median	8.4	4.7

level, therefore, the hypothesis of a common parent population was tenable. Since the null hypothesis was not rejected, the investigator was able to make valid comparisons between the experimental and control groups.

Attitudes Toward Science

Student responses on the Dutton Science Scale (57) were tabulated on the 20 items for each of the three groups. Results of the pilot study indicated that the forced-choice method used by Dutton and Stephens created a feeling of threat among the students. A large number mentioned that they refused to answer many items because they did not entirely agree or disagree with them. About 16% of the students actually qualified their responses on the test sheets. For example, under item nineteen, "I like to do science experiments," students had written the following:

> (depends)
> I think I would but have had few opportunities.
> if and when I'm successful.
> Most of the time.
> depends on the type.

To relieve this threat, the instrument was modified to include a scale designating degrees of agreement or disagreement. Since the scale did not represent equal intervals, all responses on the agree side of neutrality, scale number five, were recorded as agreeing with the statement (see Appendix B). This enabled the investigator to relieve the feelings of anxiety of the students and still make valid comparisons with Dutton's results.

A test of significance of the differences among the three groups was applied by calculating H using the Kruskal-Wallis one-way analysis of variance (65). The value was far below the tabled value for significance at the .05 level. The null hypothesis that there were no significant differences among the post-test scores of the experimental and control groups was tenable.

Inspection of the differences between the pre-test and post-test scores revealed a relatively large number of gains for one of the two experimental groups. The differences between the pre-test and post-test scores for each of the three groups were tested for significance by using the Wilcoxon Signed-Ranks test (65). No significant difference at the .05 level was found for the Control Group and the Experimental Group I; a significant difference was found for the Experimental Group II ($p = .0475$). The median score for the Control Group remained unchanged at 8.2. The medians for the experimental groups increased--from 8.1 to 8.3 for Group I and from 8.2 to 8.3 for Group II. It was noted that although the gains in attitude for Group II were significant, the increase in the median score was very small. Apparently, a significant number of subjects made very small gains in attitude.

Individual items were investigated to determine the significance of the difference between the pre-test and post-test responses. Since the scale did not represent equal intervals, only those responses in which a change from agree to disagree or a change from disagree to agree were tabulated. A Binomial test (65) was then applied to each item. The null hypothesis being tested for each item was that there was no significant difference between the pre-test and post-test responses. The alternative hypothesis for the Control Group was that there was a significant difference (two-tailed test); and for the experimental groups, that there were positive gains in attitude (one-tailed test).

Significant changes, at or beyond the .05 level, were recorded for one statement in the Control Group, one statement for the Experimental Group I, and for three statements in the Experimental Group II. It was noted that one item changed from agree to disagree in all three groups:

20. Elementary school science should be taught to groups of children with approximately the same I. Q. (p = .032 for Control; p = .002 for Group I; p = .035 for Group II)

In addition, Experimental Group II showed significant attitude change from agree to disagree for:

8. The study of science doesn't bore me, but I would never pursue it independently. (p = .020)

Significant attitude changes from disagree to agree for the Experimental Group II:

16. A lizard is an interesting and attractive classroom pet. (p = .006)

The characteristics of the subjects in Dutton's (57) study were very similar to those used in this study. The subjects in both groups were all women students and prospective elementary school teachers, had not taken a science methods course, had the same class designations and age range, and had similar science backgrounds. The investigator felt that a comparison between the two groups might provide some interesting relationships. The results of the attitude scale are tabulated in Table V. The number of the item is shown in column 1 (see Appendix B); the value of each item, 1--extreme dislike to 11--extreme like, is shown in column 2; the total numbers of student responses for each item for the two groups are shown in columns 3 and 4; and the percents of students selecting each item for the two groups are shown in columns 5 and 6.

The first general impression from Table V is the large number of students expressing favorable attitudes toward science. There are five items, all favorable toward science, which were selected by over 90% of the students in both groups. These statements center around field trips, learning about animals, student participation, and the importance of science.

TABLE V

RESPONSES OF PROSPECTIVE ELEMENTARY SCHOOL TEACHERS TOWARD SCIENCE

Item Number	Value of Item	Total Responses		Percent of Total	
		Dutton (N = 226)	Oshima (N = 77)	Dutton	Oshima
1	8.5	219	76	96.9	98.7
2	1.3	6	0	2.7	0.0
3	8.1	206	68	91.1	88.3
4	2.5	13	11	5.8	14.3
5	7.4	211	70	93.4	90.9
6	2.7	11	14	4.9	18.2
7	7.7	218	75	96.5	97.4
8	4.7	89	36	39.4	46.7
9	8.9	197	70	87.2	90.9
10	9.6	173	68	76.5	88.3
11	1.6	57	20	25.2	25.9
12	10.1	214	75	94.7	97.4
13	6.5	83	14	36.7	18.2
14	7.3	192	72	85.0	93.5
15	10.3	219	76	96.9	98.7
16	6.8	106	44	46.9	57.1
17	4.4	9	3	4.0	3.9
18	0.3	3	1	1.3	1.3
19	8.4	178	63	78.8	81.8
20	5.8	42	27	18.6	35.1

Unfavorable science attitudes center around two statements in both groups: item 8--the feeling that science was not a bore but not to be pursued independently, and item 11--the dislike for mice, worms, bugs and small crawling things.

The average scores for all students, 1.0 showing extreme dislike to 10.5 showing extreme like, are shown in Table VI. It can be readily seen that the general attitude of the vast majority of the prospective elementary school teachers in both groups is extremely high. Dutton found only 4.0% of the students with average scores below 7.1 and a median of 8.1. Only 6.5% of the students in this study had average scores below 7.1 and the median was also 8.1. It was noted that although both groups had identical highs, the lowest average in this study was 6.5-6.6 compared to 4.7-4.8 in Dutton's study.

TABLE VI

AVERAGE SCALE VALUES FOR PROSPECTIVE ELEMENTARY SCHOOL TEACHERS

Scale Value	Number of Students		Percent of Total	
	Dutton (N = 226)	Oshima (N = 77)	Dutton	Oshima
8.9 - 9.0	1	1	0.4	1.3
8.7 - 8.8	4	1	1.8	1.3
8.5 - 8.6	45	18	19.9	23.4
8.3 - 8.4	39	10	17.2	13.0
8.1 - 8.2	38	10	16.8	13.0
7.9 - 8.0	33	7	14.6	9.1
7.7 - 7.8	26	5	11.5	6.5
7.5 - 7.6	13	13	5.8	16.9
7.3 - 7.4	12	3	5.3	3.9
7.1 - 7.2	6	4	2.7	5.2
6.9 - 7.0	4	4	1.8	5.2
6.7 - 6.8	1	0	0.4	0.0
6.5 - 6.6	1	1	0.4	1.3
6.3 - 6.4	0	0	0.0	0.0
6.1 - 6.2	0	0	0.0	0.0
5.9 - 6.0	0	0	0.0	0.0
5.7 - 5.8	1	0	0.4	0.0
5.5 - 5.6	1	0	0.4	0.0
5.3 - 5.4	0	0	0.0	0.0
5.1 - 5.2	0	0	0.0	0.0
4.9 - 5.0	0	0	0.0	0.0
4.7 - 4.8	1	0	0.4	0.0

Confidence in Teaching Science

In attempting to assess the existing feelings of confidence of prospective elementary school teachers toward certain types of learning activities and any change occurring during the methods course, the Evans Confidence Scale (46) was used. As described previously, this instrument consisted of 40 items listed under eight science-learning situations. These items were equally divided among the four types of learning activities and between the biological and physical sciences.

The significance of the differences among the three groups was determined by applying the Kruskal-Wallis one-way analysis of variance test (65). The H value, 6.59, was well above the 5.99 value required to reject the null hypothesis of no difference at the .05 level.

The differences between the pre-test and post-test scores for the three groups were then tested for significance by using the Wilcoxon Signed-Ranks test (65). No significant difference at the .05 level was found for the control group; significant differences were found for both experimental groups--p less than .005 for Group I and p = .0009 for Group II.

Individual items were investigated to determine the significant difference between the pre-test and post-test responses. Only those responses in which a change from high to low confidence or from low to high confidence between the pre-test and post-test were tabulated. A Binomial test (65) was then applied to each item. The null hypothesis being tested for each item was that there was no significant difference between the pre-test and post-test responses. The alternative hypothesis for the control group was that there was a significant difference (two-tailed test); and for the experimental groups, that there were positive gains in confidence (one-tailed test).

Significant changes, at or beyond the .05 level, were recorded for 22 activities in the Experimental Group I, eight for Experimental Group II, and two for the Control Group.

Significant confidence changes from low to high confidence were found for the following items for the Experimental Group I:

1. Have children observe pets and plants at home to see how they are similar in basic needs. (p = .031)

2. Take the class on a field trip to notice the variations in plants and animals. (p = .031)

3. Do experiments to see if both plants and animals need water, food, etc. (p = .031)

5. Provide reference lists of children's books on plants and animals. (p = .016)

6. Do the experiment over again using a new solution of lime water. (p = .031)

7. Discuss suggestions from the class to determine what was the reason for the failure in the experiment. (p = .031)

9. Discuss some other related experiments which attempt to show the same results as the one which failed. (p = .006)

10. Encourage reading by children to discover possible reasons for failure in the experiment; provide reference materials for them to use. (p = .002)

13. Do experiments to show how a plant seed germinates. (p = .016)

16. Construct and use a model barometer or other equipment used by the weather man. (p = .031)

17. Use science kit to conduct experiments to determine causes of precipitation, condensation, etc. (p = .008)

20. Form a committee to investigate the question further and provide a list of resource materials for committee use. (p = .031)

21. Observe the ways that simple machines are used in the school or community and record results of observations. (p = .008)

22. Provide a list of children's books on the uses of simple machines. (p = .008)

23. Discuss with the class the basic principles behind the workings of a pulley and some of its practical uses. (p = .019)

25. Discuss some of the uses of similar simple machines such as the lever, inclined plane, ball bearing, etc. (p = .020)

28. Form a committee for further investigation of the problem; provide appropriate reference materials for them to use. (p = .008)

30. Make an observational chart of some local plants which live in the water, others which live on dry land. Observe local plants and record results. (p = .004)

33. Design an observation chart of the visible planets. Observe the visible planets and keep a record of their positions in the night sky. (p = .011)

37. Do experiments to show how a light bulb works. (p less than .001)

38. Dismantle old or broken appliances to observe and learn more about how they work. (p = .004)

39. Provide a list of references of children's books on the uses of electricity. (p = .004)

Eleven of these items were in the biological sciences and 11 in the physical sciences. Divided on the basis of activity categories, there were six in observation, six in experimentation, six in reading, and four in discussion.

Significant changes from low to high confidence were found for the following items for the Experimental Group II:

3. Do experiments to see if both plants and animals need water, food, etc. (p = .031)

6. Do the experiment over again using a new solution of lime water. (p = .016)

7. Discuss suggestions from the class to determine what was the reason for the failure in the experiment. (p = .008)

9. Discuss some other related experiments which attempt to show the same results as the one which failed. (p = .020)

13. Do experiments to show how a plant seed germinates. (p = .008)

17. Use science kit to conduct experiments to determine causes of precipitation, condensation, etc. (p = .011)

26. Discuss some experiments which the class may do to determine some of the requirements of plant life, and some conditions which may harm plants. (p = .008)

27. Do experiments with different kinds of plants (corn, watercress, wheat, bean, etc.) to show that each of them have slightly or greatly different environmental requirements for ideal growth. (p = .004)

Only one of these eight items were in the physical sciences. Five items were in experimentation, and three in discussion.

Significant changes from low to high confidence were found for the following items for the Control Group:

26. Discuss some experiments which the class may do to determine some of the requirements of plant life, and some conditions which may harm plants. (p = .016)

30. Make an observational chart of some local plants which live in the water, others which live on dry land. Observe local plants and record results. (p = .032)

Both of the items were in the biological sciences, one in discussion and the other in observation.

Achievement in Science

Achievement in science was not one of the major concerns in this study. However, the investigator felt it was necessary to include this aspect of the methods course in order to prevent bias in favor of the experimental groups. The investigator recognized the fact that methods cannot be divorced from content and that a methods course which emphasized methods at the expense of content was not necessarily superior.

As expected, the Kruskal-Wallis one-way analysis of variance (65) failed to reject the null hypothesis of no difference among the post-test scores of the three groups. The difference between the pre-test and post-test scores for each of the three groups was also found to be not significant. It was found, however, that many of the students scored higher on the post-test. The median of the raw scores increased from 51.6 to 53.0 in the Experimental Group I, from 50.0 to 51.0 in the Experimental Group II, and from 51.6 to 51.8 in the Control Group.

Summary of Student Teaching Behaviors

The student teaching experiences of the subjects in this study involved many uncontrollable factors. Many students did not teach science during their student teaching period. The reasons given were varied: many students taught in schools in which the platoon system was employed, some taught in classes where science was not a regular part of the curriculum, some taught in classes where science was not taught during the spring semester, and some taught in classes where science units had been completed prior to their arrival. A major variable was the classroom atmosphere established by the cooperating teacher. A large number of students reported that they felt obligated to perform within the structure established by their cooperating teachers. Thus, a comparative analysis was virtually impossible. However, the investigator believed that an examination of the behaviors exhibited by those students who actually taught science might provide some information relative to their training in science methods. The investigator reasoned that the behaviors would be independent of the student teaching situation, that is, a student who lacked confidence in doing experiments or demonstrations would exhibit this feeling regardless of the student teaching situation.

The data for this part of the study was gathered through the use of a questionnaire. Although 84% of the forms were returned, many of them were not usable since the students did not teach science. The Experimental Group I was eliminated from this part of the study since only seven, or 27%, of the 26 questionnaires were usable. The Experimental Group II had 17 of the original 28, or 61%; and in the Control Group, 16 of the original 23, or 69%, were usable.

Since the eight confidence items and the six attitude items in the questionnaire were taken from the Evans Confidence Scale (46) and the Dutton Science Attitude Scale (57), these were scored in the same manner as in the original tests. A confidence score and an attitude score for each subject was calculated.

To test for any difference, the null hypothesis of no difference between the control group and the experimental group was tested using the Mann-Whitney U test as given by Siegel (65). The Kruskal-Wallis test was not used since the Experimental Group I was eliminated from this part of the study. In a one-tailed test on the confidence scores, the null hypothesis was rejected on the .01 level. This indicated that the confidence scores of the experimental group were significantly higher than those of the control group.

Although the median scores on the attitude scale for both groups were higher than the median scores on the pre-tests, there was no significant difference between the two groups. The median score increased from 8.2 to 8.4 in the control group and from 8.0 to 8.4 in the experimental group.

The average time spent on science per week for both groups was well within the range of 45 minutes per week in kindergarten to 135 minutes in the eighth grade reported in Blackwood's (17) survey. The median for the control group was 100 minutes per week and the median for the experimental group was 86 minutes per week.

Summary of Findings

The results of this study indicated that the two different methods of presenting the materials in a science methods course for prospective elementary school teachers produced no significant changes in attitudes toward science in the three groups. Significant changes were obtained for specific items. The median score remained unchanged for the control group; slight increases were recorded for the experimental groups.

The control group showed no significant change in confidence in teaching science. Significant gains in confidence were found for both experimental groups--p less than .005 for Group I and p = .006 for Group II. There were a total of thirty activities significant at or beyond the .05 level in the two experimental groups--eighteen in the biological sciences and twelve in the physical sciences; there were eleven experimentation activities, seven discussion activities, six observational activities, and six reading activities.

Data from the science achievement test showed no significant difference between the pre-test and post-test scores for each of the three groups. It was found, however, that many of the students scored higher on the post-test. There was an increase in the median of the raw scores in all three groups.

The Summary of Student Teaching Behaviors in Science questionnaire revealed increases in median scores but no significant changes in attitudes toward science in both control and experimental groups. The confidence scores of the experimental group were significantly higher than those of the control group. The average time spent on science per week for both groups was found to be well within the range established in a national survey.

CHAPTER V

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

General Summary of the Investigation

This study was made to determine the extent to which attitudes toward science and confidence in teaching science of a selected group of prospective elementary school teachers could be favorably changed by two methods of presentation in an elementary science methods course. The study originated in a concern for finding new avenues of communication for meeting the pre-service needs of elementary school teachers.

Certain basic assumptions related to this study were involved:

1. Prospective elementary school teachers will increase in a feeling of competence as they become familiar with how children learn science.
2. Prospective elementary school teachers will increase in a feeling of competence as they manipulate science equipment and perform science activities.
3. Prospective elementary school teachers will increase in favorable attitudes toward science as they become involved in "doing" science.
4. A science methods course for prospective elementary school teachers designed to emphasize how science is learned can be organized and integrated into the existing curriculum of the

University teacher education program.

In exploring these assumptions, one control group and two experimental groups were organized. The content of the course consisted of activities designed to give better insight into how to work in a scientific manner, how to evaluate what is read and done in science, and how to make wise decisions in solving problems in science. The course was designed to prepare students adequately not only to teach the contemporary science materials effectively but also to exercise judgment in the selection of such materials and to contribute to their further development.

All three groups were pre-tested with the Evans Confidence Scale (46), the Dutton Science Attitude Scale (57), and the Read General Science Test (59). The students in the two experimental groups carried out their activities individually with little direction from the instructor. The control group used the same materials in the same sequence, except the activities were demonstrated by four-student teams. Each group was post-tested at the conclusion of the course. Pre-test and post-test differences for the groups were expected to indicate the effects of the difference in the method of presenting the materials. A Summary of Student Teaching Behaviors in Science questionnaire was also used to gather information concerning the expressed behaviors of the subjects during their student teaching period.

Summary of Results and Conclusions

Results of this study indicated that the two different methods of presenting the materials in a science methods course for prospective elementary school teachers produced no significant changes in attitudes toward science in the three groups. Significant changes were obtained for specific items.

Since it is generally believed that attitudes are learned and that an individual's attitudes are intimately related to the individual's involvement in a task (49, 66), the investigator expected significant changes in the experimental groups in which the subjects worked in science. However, further study of attitudes and attitude changes revealed that time was an important factor. There is evidence that significant changes will become apparent only after a time lapse. Craig (67), in Science for the Elementary-School Teacher, says:

> We should provide opportunities for the learner to react to the learning, for a learning element to be absorbed, to be thought over, to become acceptable in a real sense. We might think of this process as "internalizing"; that is, the process in which the learner takes the learning and works it over in his mind, combining it with materials that he has already learned.

Breer and Locke (49), in analyzing the least successful of their seven studies, say:

> There are other factors that might be mentioned. There is, for example, the duration of the experiment, more specifically the fact that subjects met for only 50 minutes a week for 13 successive weeks. . . . It is quite possible that in the Wisconsin experiment those 13 hours got lost in the shuffle of competing events and for this reason lacked the salience required to produce significant attitude change.

The Wisconsin study was the only field experiment in the series. Since no attitude change was significant at the .01 level and a very few at the .05 level, the college classroom situation was abandoned for short and highly concentrated laboratory experiments. In these laboratory studies, p values of .01 and .001 were very common.

While this is not to suggest that changes in attitudes toward science be attempted in a similar fashion, it does indicate the possibility that a methods course extended over an entire semester may produce significant results. It also indicates the possibility that changes may be found to exist after a longer time lapse, perhaps a year after the course.

Other related studies (68, 69, 70, 71) concerning science interests and attitudes have also indicated that attitudes are difficult to change.

As a result of individual investigations, the students in the experimental groups increased significantly in their feeling of confidence in teaching science in the elementary-school classroom. Increases were found in both the physical sciences and biological sciences, and also in all four types of teaching situations--experimentation, observation, discussion, and reading. It was encouraging to note that increases were found for activities which were similar to those conducted in the methods course, as "Do experiments to show how a plant seed germinates," as well as activities unrelated to those conducted in class, as "Use science kit to conduct experiments to determine causes of precipitation, condensation, etc." These significant changes may indicate a carry-over of the feeling of confidence from one teaching situation to another.

Although the experimental groups did not achieve significantly more than the control group as measured by the Read General Science Test (59), all three groups increased their median scores. There is no doubt, then, that the experimental method is at least as effective as the control method. In a similar study, Eccles (72) found no significant difference in science achievement in two approaches to teaching a science methods course. These courses were taught by R. Will Burnett and J. Myron Atkin at the University of Illinois.

The results of the Summary of Student Teaching Behaviors in Science were not surprising in view of the results obtained from the original test instruments. However, all generalizations must be qualified since the conditions under which the data were collected varied so much. A more accurate reflection of the feelings and attitudes of the subjects will be found in behaviors exhibited in their own classrooms, that is, when the subjects are employed as certified teachers.

Specifically, the following conclusions seem to be warranted from this study:

1. Hypothesis 1, that there is no significant difference (.05 level of confidence) in scores in confidence toward teaching science of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course, is untenable in the light of the results of the analysis of the data.
2. Hypothesis 2, that there is no significant difference (.05 level of confidence) in scores in attitudes toward science of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course, is tenable.
3. Hypothesis 3, that there is no significant difference (.05 level of confidence) in scores in science achievement of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations in a science methods course, is tenable.
4. Hypothesis 4, that there is no significant difference (.05 level of confidence) in summaries of student teaching behaviors

in science of elementary education majors who have experienced lecture-demonstrations and those who have experienced individual investigations, is partially untenable--the confidence scores were significantly higher in the experimental groups but there was no difference in attitude scores.

5. A science methods course for prospective elementary school teachers designed to emphasize how science is learned can be successfully organized and integrated into the existing curriculum of the University teacher education program.

Recommendations

Finally, from this study, there are several recommendations for further exploration of the science methods course for the prospective elementary school teacher.

1. In the first place, it is obvious that reliance upon the methods course to accomplish the total job of pre-service education in science is unwarranted. This possibility was never in the framework of this study, but perhaps that doubt ought to be formally expressed.

   The methods course in pre-service education needs to be thought out carefully and related to the kinds of supports provided by the subject-matter areas to make certain that full use of the course has been made. In general, it would seem likely that the new role of the methods course should be seen in ways that are strengthening to the total program of pre-service education.

2. As far as the two methods of teaching a science methods course

for the prospective elementary school teacher are concerned, it would seem desirable to try out a variety of kinds of programs that may be useful to both teachers and pupils. In this study, the emphasis was focused on lecture-demonstrations and individual investigations. In other studies, the focus might be on content and materials included in the methods course. Another aspect of investigation would be timing. This study was conducted within the limits prescribed by the existing schedule--two 75-minute sessions for eight weeks. Since evidence cited previously indicated that time is an important factor, a course meeting for shorter sessions for the entire semester might be more valuable.

3. A third set of concerns for further study can be grouped around learning how to use methods and materials. Pre-service teachers need help in understanding the best ways to use the various kinds of programs offered by a methods course. Direct teaching may set certain expectations or habits of approach that may need re-examination when the purpose is different. Also, a number of students may come to think of methods as a series of self-contained "recipes" and regard them as a set of rules to follow rather than something personal--something that varies with each individual and with each situation. Helping students approach methods of teaching science in another frame of mind may be a problem for further study. The use of a practicum in which pre-service teachers learn how to build models, simple equipment, etc. may be another area for study. Although the content of this study included

activities of this nature, the major emphasis was not on these objectives. Added opportunities to use simple hand tools, manipulate devices, etc. in a practicum may prove to be valuable.

4. Evaluation of the effects of such short-term approaches to preservice education may also be worth further study. The evaluation of individual studies proves of value chiefly in planning those yet to be conducted. The investigator has already made arrangements for a follow-up study to be conducted within the next two years. Seventy-four members of this study have agreed to participate and have provided their names and permanent addresses to the investigator.

SELECTED BIBLIOGRAPHY

(1) National Society for the Study of Education. *Science Education in American Schools, The Forty-sixth Yearbook, Part I.* Chicago: The University of Chicago Press, 1947.

(2) Matala, Dorothy C. "Current Activity in Elementary and Junior High School Science." *School Science and Mathematics*, Vol. 61 (May, 1961) 339-367.

(3) Mallinson, Jacqueline V. "The Current Status of Science Education in the Elementary School." *School Science and Mathematics*, Vol. 61 (April, 1961) 252-270.

(4) Schlessinger, Fred R. "Science Facilities for Our Schools--K-12." *The Science Teacher*, Vol. 30 (December, 1963) 41-72.

(5) Smith Eugene H. "An Analysis of Some Prominent Viewpoints on Teaching Elementary School Science." *Science Education*, Vol. 47 (March, 1963) 188-193.

(6) Pierce, William M. "Elementary Teaching Roadblocks." *The Science Teacher*, Vol. 30 (April, 1963) 23-35.

(7) Victor, Edward. "Why Are Our Elementary School Teachers Reluctant to Teach Science?" *Science Education*, Vol. 46 (March, 1962) 185-192.

(8) Rising, Gerald R. "Recommendations for the Preparation of Elementary Teachers in Science." *Science Education*, Vol. 49 (October, 1965) 359-362.

(9) Fish, Alphoretta S., and Bernice Goldmark. "Inquiry Method: Three Interpretations." *The Science Teacher*, Vol. 33 (February, 1966) 13-16.

(10) Nichols, Benjamin. "Elementary Science Study: Two Years Later." *Journal of Research in Science Teaching*, Vol. 2 (December, 1964) 288-292.

(11) Thier, Herbert D. "Quantitative Approaches to Elementary Science." *The Instructor*, Vol. 75 (January, 1966) 65-104.

(12) "The 'Process Method' of Teaching Science." *Grade Teacher*, Vol. 83 (January, 1966) 60-122.

(13) Hurd, Paul DeHart. "Toward a Theory of Science Education Consistent with Modern Science." *Theory into Action*. Washington: National Science Teachers Association, 1964.

(14) Hurd, Paul DeHart. "Science Teaching for a Changing World." *Scott, Foresman Monographs on Education*. Chicago: Scott, Foresman and Company, 1963.

(15) National Society for the Study of Education. *Rethinking Science Education, The Fifty-ninth Yearbook, Part I*. Chicago: The University of Chicago Press, 1960.

(16) Suchman, J. Richard. "Inquiry in the Curriculum." *The Instructor*, Vol. 75 (January, 1966) 24+.

(17) Blackwood, Paul E. *Science Teaching in the Elementary Schools, A Survey of Practices*. Washington: U. S. Dept. of Health, Education, and Welfare, 1965.

(18) Ploutz, Paul F. "Trends in the Elementary Science Curriculum." *Science and Children*, Vol. 3 (February, 1966) 39-41.

(19) Lockard, J. David. *Third Report of the Information Clearinghouse on New Science and Mathematics Curricula*. American Association for the Advancement of Science and the Science Teaching Center, University of Maryland, March, 1965.

(20) Stephen, Beverly, ed., *SCIS Newsletter*. (March 23, 1966) The Science Curriculum Improvement Study, Berkeley, California.

(21) Hale, Helen E. "Developing an Articulated Science Curriculum." *The Science Teacher*, Vol. 33 (April, 1966) 9-12.

(22) Triger, Seymour. "New Forces Affecting Science in the Elementary School." *Science and Children*, Vol. 1 (October, 1963) 22-23.

(23) McCarthy, Donald W. "Mr. Reader, Mr. Doer, and Mr. Problem Solver." *Science and Children*, Vol. 1 (February, 1964) 5-7.

(24) Taylor, Toni, ed., *Grade Teacher*, Vol. 82 (January, 1965).

(25) Liston, James M., ed., *Grade Teacher*, Vol. 83 (January, 1966).

(26) Blough, Genn O., ed., *The Instructor*, Vol. 73 (January, 1964).

(27) Owen, Mary E., ed., *The Instructor*, Vol. 74 (January, 1965).

(28) Noon, Elizabeth F., ed., *The Instructor*, Vol. 75 (January, 1966).

(29) *Opportunities for Summer Studies in Elementary Science*. Washington: National Science Teachers Association, 1966.

(30) *Summer Institutes and Cooperative College-School Science Project for Elementary School Personnel*. Washington: National Science Foundation, 1966.

(31) Zafforoni, Joseph, and Edith Selberg. "Re-Education of Teachers Through Inservice Programs." *New Developments in Elementary School Science*. Washington: National Science Teachers Association, 1963.

(32) Leake, John B. "Missouri's Inservice Science Workshop Program." *Supervision for Quality Education in Science*. Washington: U. S. Dept. of Health, Education, and Welfare, 1963.

(33) Barnard, J. Darrell. "Implications for Science Education." *Supervision for Quality Education in Science*. Washington: U. S. Dept. of Health, Education, and Welfare, 1963.

(34) Gega, Peter C. *Science in Elementary Education*. New York: John Wiley and Sons, Inc., 1966.

(35) Carin, Arthur, and Robert B. Sund. *Teaching Science Through Discovery*. Columbus, Ohio: Charles E. Merrill Books, Inc., 1964.

(36) Rooke, Jerome J. "Methods Courses for All Teacher--A Must!" *The Balance Sheet*, Vol. 42 (December, 1960) 166+.

(37) Keliher, Alice V. "Teacher Training by the Activity Method." *Progressive Education*, Vol. 11 (October, 1934) 368-372.

(38) Keliher, Alice V. "Do as We Say or Do as We Do?" *Progressive Education*, Vol. 14 (May, 1937) 364-369.

(39) Lee, Dorris. "Methods of Teaching." *NEA Journal*, Vol. 51 (September, 1962) 48-49.

(40) Spalding, Willard B. "Some Thoughts about the Education of Teachers." *The Educational Forum*, Vol. 29 (March, 1965) 265-273.

(41) Dierenfield, R. B. "Let's Practice What We Teach." *The Journal of Teacher Education*, Vol. 10 (June, 1959) 207-210.

(42) Hoover, Kenneth H. "Teaching Methods of Teaching by Demonstration and Application." *The Clearing House*, Vol. 33 (October, 1958) 90-91.

(43) Hedges, William D., and Mary Ann MacDougal. "Effective Teaching of Science in the Elementary Schools of Virginia--A Basic Dilemma." *Virginia Journal of Education*, Vol. 56 (May, 1963) 11-12.

(44) Scott, Lloyd. "Science is for the Senses." Science and Children, Vol. 2 (March, 1965) 19-22.

(45) Washton, Nathan S. "Improving Elementary Teacher Education in Science." Science Education, Vol. 45 (February, 1961) 33-34.

(46) Evans, Lewis D. "How Confident Are Elementary School Teachers about Teaching Science?" Educational Research Bulletin, Vol. 40 (October, 1961) 179-185.

(47) Witty, Paul A. "The Role of Attitudes in Children's Failures and Successes." NEA Journal, Vol. 37 (October, 1948) 422-423.

(48) Ragan, William B. Modern Elementary Curriculum. Rev. ed. New York: Henry Holt and Company, 1960.

(49) Breer, Paul E., and Edwin A. Locke. Task Experience as a Source of Attitudes. Homewood, Illinois: The Dorsey Press, 1965.

(50) Perrodin, Alex F. "Children's Interests in Elementary School Science." School Science and Mathematics, Vol. 65 (March, 1965) 259-264.

(51) Eiss, Albert F. "Science Preparation for Elementary Teachers." Science and Children, Vol. 2 (May, 1965) 17-18.

(52) Fischler, Abraham S. "Science, Process, and the Learner: A Synthesis." Science Education, Vol. 49 (December, 1965) 402-409.

(53) Frank, Nathaniel H. "The Cooperative Program in Teacher Education." ESI Quarterly Report. Watertown, Massachusetts: Educational Services Incorporated, 1965.

(54) Sternlicht, Manny. "Undergraduate Educational Methodology: Term Projects Versus Term Paper." Science Education, Vol. 49 (April, 1965) 225-229.

(55) Karplus, Robert, and Herbert D. Thier. "Science Teaching is Becoming Literate!" Education Age, Vol. 2 (Jan.-Feb., 1966) 40-45.

(56) Hines, Sallylee. "A Study of Certain Factors Which Affect the Opinions of Elementary School Teachers in the Teaching of Science." (unpub. Ed. D. thesis, Oklahoma State University, in progress).

(57) Dutton, Wilbur H., and Lois Stephens. "Measuring Attitudes Toward Science." School Science and Mathematics, Vol. 63 (January, 1963) 43-49.

(58) Goodlad, John I. School Curriculum Reform in the United States. New York: The Fund for the Advancement of Education, 1964.

(59) Read, John G. *Manual: Read General Science Test*. New York: World Book Company, 1951.

(60) Thurstone, Louis L., and Ernest J. Chave. *The Measurement of Attitude*. Chicago: The University of Chicago Press, 1929.

(61) Edwards, Allen L. *Techniques of Attitude Scale Construction*. New York: Appleton-Century-Crofts, 1957.

(62) Thurstone, Louis L., and Ernest J. Chave. *The Measurement of Attitude*. Chicago: The University of Chicago Press, 1948.

(63) Stevens, S. S. "A Metric for the Social Consensus." *Science*, Vol. 151 (February 4, 1966) 530-541.

(64) Barnes, Fred P. *Research for the Practitioner in Education*. Washington: National Education Association, 1964.

(65) Siegel, Sidney. *Nonparametric Statistics for the Behavioral Sciences*. New York: McGraw-Hill Book Company, Inc., 1956.

(66) Sherif, Carolyn, Muzafer Sherif, and Roger Nebergall. *Attitude and Attitude Change*. Philadelphia: W. B. Saunders Company, 1965.

(67) Craig, Gerald S. *Science for the Elementary-School Teacher*. New York: Ginn and Company, 1958.

(68) Wickline, Lee E. *The Use of Motivational Films to Favorably Change the Attitudes of High School Students Toward Science and Scientists*. Washington: U. S. Dept. of Health, Education, and Welfare, 1962.

(69) Gatewood, Claude W. "A Study of the Effects of the Oklahoma State University Traveling Science Teacher Program on the Attitudes of High School Students Toward Science and Scientists." (unpub. Ed. D. thesis, Oklahoma State University, 1962).

(70) Weisgerber, Robert A. "Motivation for Science." *The Science Teacher*, Vol. 28 (February, 1961) 20-23.

(71) Leake, John B. "A Study of the Attitudes of Elementary Teachers Toward Science." (unpub. Ed. D. thesis, Oklahoma State University, in progress).

(72) Eccles, Priscilla J. "An Evaluation of a Course in Teaching Science in the Elementary School." (unpub. Ed. D. thesis, University of Illinois, 1958).

APPENDIX A

PARTIAL OUTLINE OF COURSE ACTIVITIES

SCIENCE UNDERSTANDINGS

Understandings Basic to Life Science

1. Living things come from living things.
2. Life seems to be continuous although organisms seem to have an average life span.
3. There exists in nature a dynamic equilibrium which shows little apparent change over a period of time.
4. Most ideas about living things must allow for exceptions.
5. The matter of which living things are composed is eternal.
6. In all organisms, the greatest struggle for existence is the struggle for useable energy.
7. The study of living things may occupy days, weeks, months, years, centuries, and thousands of centuries, depending upon the perspective selected.
8. Experimentation in life science is difficult because of the number of variables which require control.
9. All living things respond to their environment.
10. Present living forms are the result of adaptation to environment and genetic changes which are continuous.

Physical Science Understandings

1. We understand our physical surroundings only as well as they can be measured.
2. Descriptions of objects and events depend upon the point of view.
3. Our interpretation of interactions seems to be basic to the physical sciences.
4. Some ideas that seem fundamental to the present concept of the physical world are:
    1. The particle nature of matter.
    2. The electrical nature of matter.
    3. The conservation concepts.
    4. The concept of force as related to change.
    5. The matter-energy relationships.

MEASUREMENT

PURPOSE

The understanding and theories of science depend in large part upon measurements and the precision of those measurements. The objective in this work is to arrive at an understanding of the fundamental problems of an arbitrary linear measurement system and the application of this system to a "search for similarity" activity.

MATERIALS

Cotton string of various lengths
Soda straws
Assorted circular objects
Graph paper
Irregular shaped objects such as leaves

INTRODUCTION AND INVESTIGATION I

The instructor will supply each student with a precut length of string. The students will now be instructed to measure (without the aid of other tools) similar simple objects such as desks, tables, windows, chalkboard or room length and width making certain to record these measurements for future reference.

ASSIMILATION I

The instructor should now attempt to lead the group into an agreement on the size of some commonly measured object. Agreement will not be possible since all strings are of different length. This leads to a discussion of a standard unit for this class. This standard unit is to be named by this group.

INVESTIGATION II

The class is now requested to measure some object, such as a baby food jar lid, with a total diameter or length measure less than the string length. The object here is to force the subdivision of the above agreed standard.

ASSIMILATION II

The idea of base ten and ten divisions is quite helpful for future work with the metric system and the instructor may now wish to hand out the problem of equal divisions (preferable as homework) using the soda straw. "Problem mark this straw off in ten equal segments without the aid of any manufactured measuring device."

INVESTIGATION III

Various round objects should be supplied to the class with a brief discussion of what measurements may be taken such as around, across, etc. What is similar about these objects in terms of measurement? The instructor will allow students to measure many objects before the assimilation session.

ASSIMILATION III

The instructor will pool the measurements taken by the group and record this using the chalkboard or suitable projection equipment. The group should discover the relationship of circumference to diameter if this work has been preceded by "patterns in data."

INVESTIGATION IV (optional)

It may be desirable to determine the approximate area of some objects of irregular sizes using graph paper and approximation procedures.

HISTORY

These activities have been performed in various ways with all age groups and have proven to be, not only helpful, but also enjoyable. One of the most unique creative endeavors memorable to this writer was the fifth-grade boy who divided his soda straw by stoppering one end and filling with drops of water to determine one tenth the length.

PATTERNS AND DATA

PURPOSE

This activity is designed to give students practice in processes of analysis before actual measurement statistics are encountered.

INTRODUCTION

The instructor will probably want to use several very simple examples of patterned numerical data allowing the class time to suggest possible solutions and try their solutions out. The following is an extremely simple mathematical pattern but difficult to see:

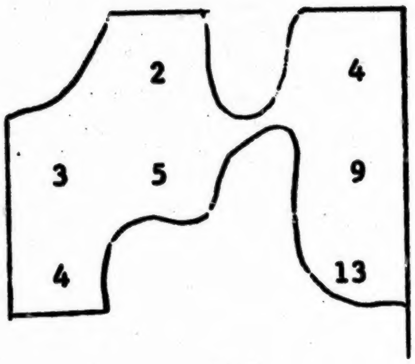
1	3	8	6	4	7	0
9	7	2	4	6	3	?

This one is also simple but less evident. What is the key?

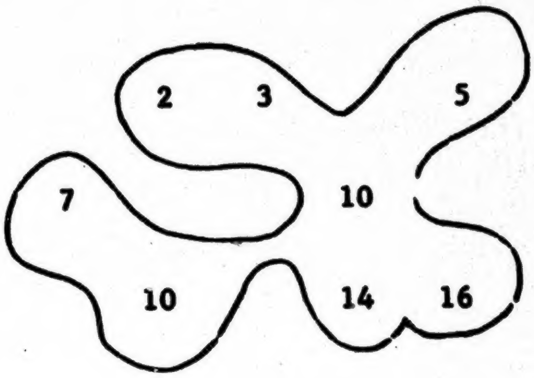
0	1	3	5	2	4
2	4	8	12	6	?

INVESTIGATION

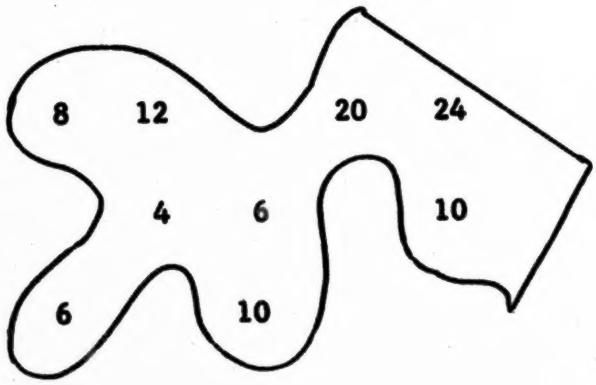
The following examples will prove interesting and challenging to all but the most proficient students. When students finish these activities, they may wish to try their hand at making up a few. I enjoy pretending this is a part of some lost map and probably the key to a fortune if we can only supply the missing numerals. Some may have several solutions.



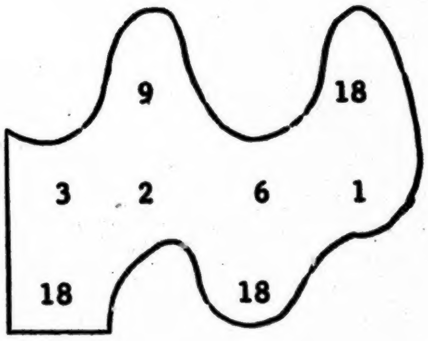
(1)


2
3
5
7
10
10
14
16

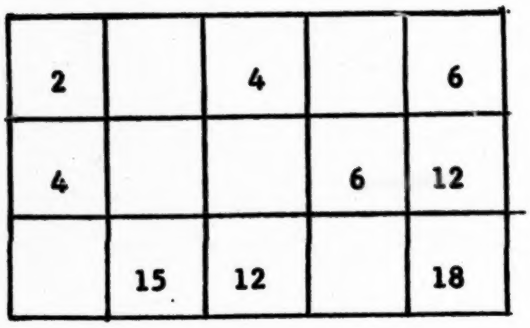
(2)


8
12
20
24
4
6
10
6
10

(3)

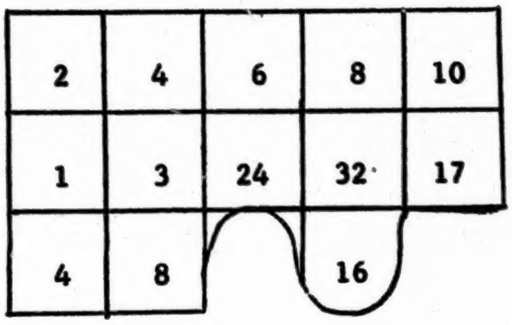

9
18
3
2
6
1
18
18

(4)

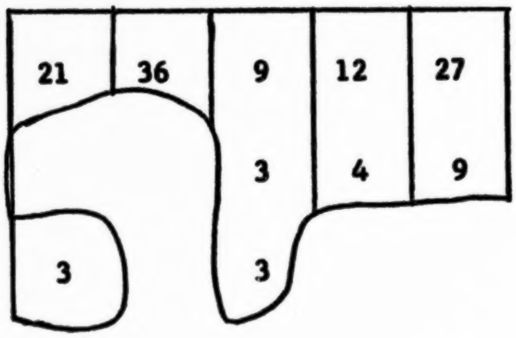


2		4		6
4			6	12
	15	12		18

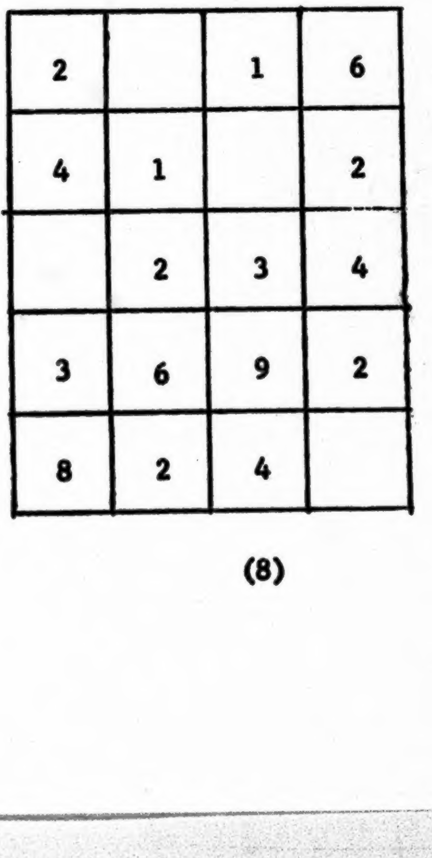
(5)


2
4
6
8
10
1
3
24
32
17
4
8
16

(6)


21
36
9
12
27
3
4
9
3
3

(7)



2		1	6
4	1		2
	2	3	4
3	6	9	2
8	2	4	

(8)

SEEDS

PURPOSE

1. To develop some understanding of living material.
2. To develop a systematic way of recording data.
3. To practice quantitative techniques.

MATERIALS

Expendable. Baggies
Paper towels
Beans, corn, unknown seed
Volumetric graduate
Peat
Milk carton (½ pint)

Kit. Ruler and/or soda straw balance
Metric scale

INTRODUCTION

Distribute materials to each student. The preliminary activities are described in a set of two handouts. The first will be distributed to the students at the introductory session; and the second, one week later.

INVESTIGATION

The two lessons are self-explanatory. Lesson 2 provides for a retrial of Lesson 1, pointing out ways to improve record keeping. The third week an investigation of optimum watering for seed germination and growth should be started. Without some standardized watering procedure, other variables cannot be studied with a high degree of reliability.

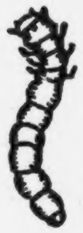
ASSIMILATION

Assimilation is almost an individual affair for seeds. Each student should be able to describe his observations by some quantitative methods. A good understanding of how seeds develop into plants should be reached. Ability to control variables to as great an extent as possible should be achieved.

HISTORY

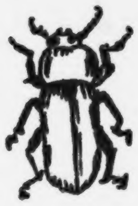
Studies at primary grade levels have been made using lengths of construction paper to graph growth from day to day. Other seeds may be used on an individual student basis. Comparison or descriptions of adult plants can be made to determine possible relationships. The effect of different environmental factors may be studied. Data can be collected and graphed showing the comparative growths of a group of the same seeds or different seeds.

MEAL"WORMS"



PURPOSE

To find out what we can about this organism.



MATERIALS

Stock. Mealworms

Expendable. Food
Baby food jars

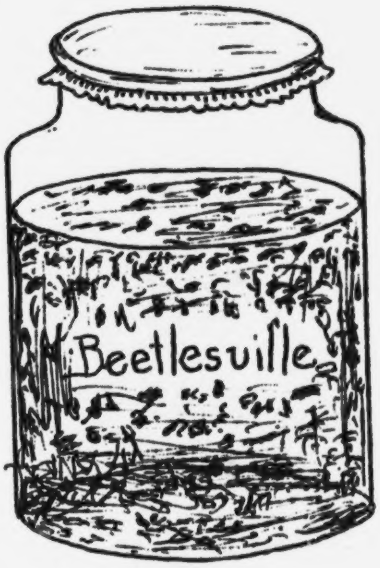
Kit. Soda straw and/or ruler balance

INTRODUCTION

Let each student select a mealworm for himself and put it and some food in the jar. A diary for each mealworm is required. The class may be asked what information might be expected to be discovered.

INVESTIGATION

Some time should be spent each day bringing the mealworm diary up to date. Various experiments may be run on each mealworm.



ASSIMILATION

Periodically, the whole class should compare records and experiences to determine whether or not mealworms are similar to each other.

HISTORY

Mealworms have been studied by other classes, both primary and intermediate. Many different observations have been made relative to the mealworm; such as, the rate of change in length as a function, food, light, temperature, pressure; change in number of segments; rate of change of weight (mass); change in body contour and attachments; volume versus surface area; velocity backward and forward; how it eats; how well it can search for food; and whether or not it comes from an egg.

SORTING

PURPOSE

To introduce methods of systematics and the making of keys.

"Distinguishing those that have feathers, and bite, from those that have whiskers, and scratch."-- The Hunting of the Snark

MATERIALS

Stock. Jars of objects

INTRODUCTION

Students may be asked to put their purses in a pile on a table at the front of the room. As each purse is held up by the teacher, the owner is to identify it. When all purses have been returned in this manner, a discussion is carried on concerning what properties enabled the students to identify their purses.

The jars are now distributed and students are asked to group the objects in each jar so that at each separation two choices may be made. For example, colored versus uncolored objects.

INVESTIGATION

Several groupings, all of which may be correct, will be achieved. Some of these should be written on the chalkboard to be tested by the rest of the class.

ASSIMILATION

One "official" key should be agreed on and entered in each teacher's notebook. If the objects from the jar are coded; A, B, C, etc.; some practice may be obtained by holding up one of the objects and requesting the coded letter, as determined by the key.

It is strongly recommended that the plant phyla key which is reproduced in History be used at this point with an assortment of freshly gathered plants.

HISTORY

Many biology courses deal with taxonomy of plants and animals. Emphasis in these courses is placed on similarity of organisms based on natural evolutionary relationships.

A simple plant phyla key is reproduced below and may be used with plant specimens.

1. Plants with roots, stems, and leaves
    2. Plants with roots, stems, leaves and seeds
        3. Plants with seeds on scales of cones . . . Gymnosperms
        3. Plants with flowers and seeds enclosed in a fruit
            4. Seeds with one-part seed . . . . "Monocots"
            4. Seeds with two-part seed . . . . "Dicots"
    2. Plants with roots, stems, and leaves and no seeds . Ferns
1. Plants without roots, stems, and leaves
    2. Plants with green color
        3. Living mostly on land but in damp places . . Mosses
        3. Living mostly in water (but some on land) . Algae
    2. Plants without green color living mostly on land but in damp places . . . . Fungi

PENDULUM, FORCES, AND BALANCE

PURPOSE

This is a series of structured activities designed to introduce the student to variables, applied measurement, and inquiry into simple machines.

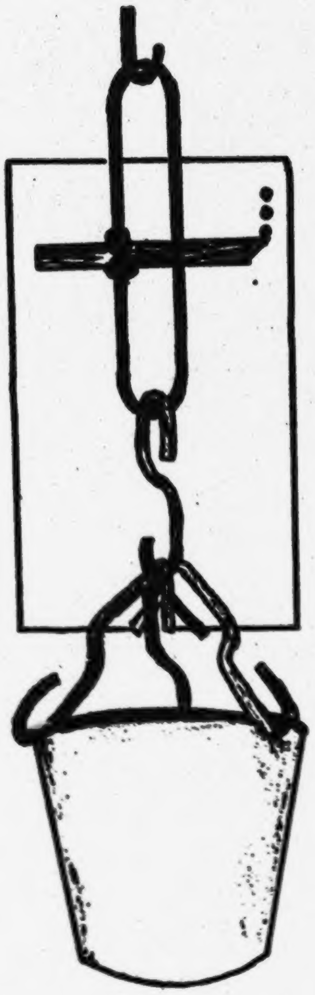
MATERIALS

Listed with each activity.

INTRODUCTION

This material will be more effective if its use has been preceded by some activities involving measurement and mathematical games involving patterns, "See Patterns in Data." The series is arranged in the following order in an effort to control the number of variables and the increasing degree of sophistication. It is generally necessary for the instructor to have a model of each experimental setup. This may be used to introduce the problem (such as how many marbles equals one golf ball) as well as a source of reference for the students during the experiment setup time.

The instructor may wish to briefly discuss the model, asking leading questions and formulating the group suggestion into an organized inquiry technique. For example, it may be necessary with some groups to explain briefly what data is and some ways of organizing and arranging it for convenience and orderly analysis. There are six separate structures connected by basic ideas of mechanics that will be treated from this introductory point of view.



The Rubber Band Scale

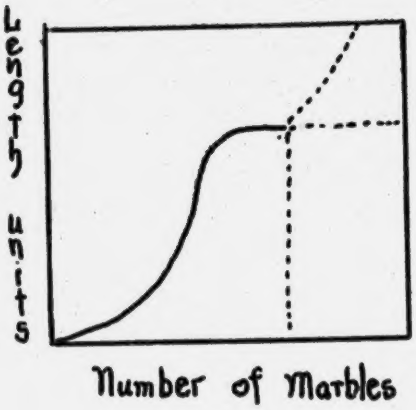
MATERIALS

- Paper cup
- Paper clips
- Marbles
- 3 X 5 index cards (ruled)
- Rubber bands (assorted)
- Splints
- Support

INVESTIGATION

There are essentially two variables under consideration (the number of marbles and the length of the rubber band). There may be individual students desiring to consider other variables. They should be encouraged. Individuals will want to calibrate their rubber bands by adding marbles in some organized way (same number each time or double the number, etc.) and marking the position of the pointer after each weight change.

Each student should determine several points as shown and construct a graph of length versus marbles.

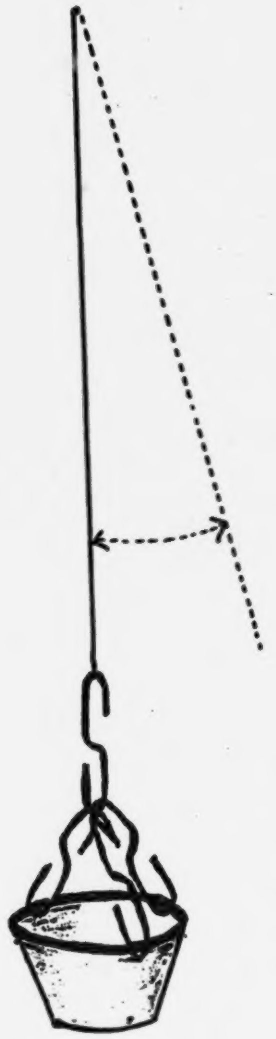


ASSIMILATION

We are now ready to look for a predictive system or generalization concerning the stretch versus the number of marbles. The class will probably conclude a linear relationship. This relationship may be tested beyond the range of the experimental data providing a valuable lesson in the dangers of extrapolation.

HISTORY

The rubber band scale has been used for many years by curious students of force. This particular system is especially useful for intermediate grade-level students. Students seem to enjoy using arbitrary units of weight; however, adults often have difficulty with this idea. Experience seems to indicate an increased understanding and appreciation for the commercial spring scale results from this activity.



Pendulum

MATERIALS

A timing device
Thread
Mass units
Paper clips
Plastic tape
Nut cups

INVESTIGATION

The most apparent variables of a pendulum are quickly agreed upon by almost any group. They are mass of the bob, length of the thread, distance displaced from the vertical, and the rate of swinging. They will generally not agree on the relatedness of these variables, nor will it be evident that various combinations of control variables are necessary if conclusive evidence is to be assembled. Teachers should not discuss this aspect; students will discover and hopefully remember this basic idea.

Generally, it is desirable to have students work in teams of two since the mechanics of collecting data requires rapid physical manipulation.

Students should now construct the pendulum using the teacher's model for reference as necessary. Each pair of investigators must agree on techniques of measuring.

After a team has reached a valid generalization based on their collected data, it is desirable to have them plot a graph and predict the behavior of pendulums of various lengths, weights, and displacements. These predictions can now be tested.

HISTORY

The pendulum is a classic example of a simple inexpensive device involving basic elements of inquiry. The mathematical problems involved restrict the lower limit of this activity (as written) to intermediate grade-level children. The resourceful curious students become involved in modifications of the pendulum such as how will it behave if moved to various places, or will a vertical vibrating device (such as our spring scale set in motion) behave the same way? Would a student in Denver, Colorado, agree with our results? This provides an opportunity to communicate with others in inquiry learning.

Ruler Balance

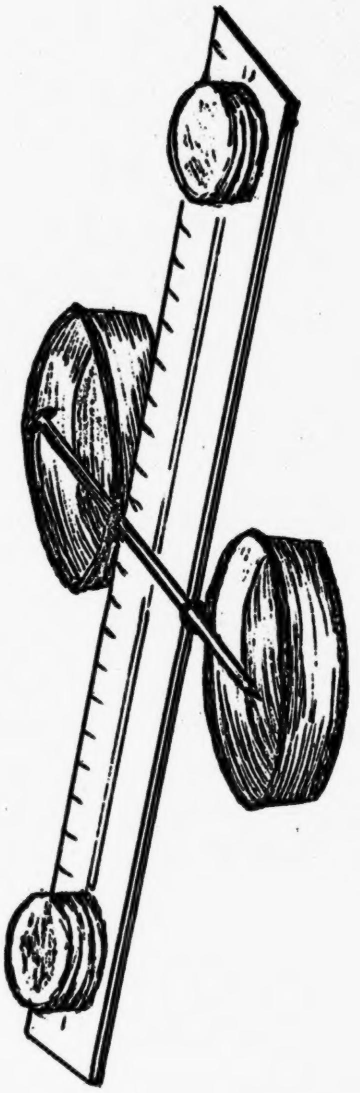
MATERIALS

Plastic ruler (with metric units)
No. 10 nail
Rubber band
Two jar lids
5-6 pennies

INVESTIGATION

The investigator is required to construct the ruler balance making reference to the drawing and model.

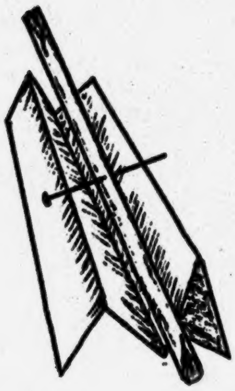
The ruler balance is quite sensitive and will require a considerable degree of patient manipulation if the initial balanced state is to be obtained. It is impossible to determine how the balance behaves without an initial balanced condition. After the initial balance has been established, the investigator is asked to place pennies on the ruler in various numbers and positions to determine if a symmetry exists and arrive at a quantitative relationship that accurately predicts this symmetry.



HISTORY

This inquiry into the behavior of balanced conditions is most adaptable to investigators with measurement skills already developed or students presently working to develop these skills. Success is not limited by age, however, as described here. This is an intermediate level inquiry. Past experiences have found students investigating the likeness of pennies, the relatedness (mass) between various coins, and how this compares to monetary value. Students have mounted cups on this balance to determine relative masses of various liquids and small crystalline solids. The ruler balance is a very sensitive mass determination device. Students and teachers continue to ponder the problem of how many possible combinations of balance factors are possible with five pennies.

Soda Straw Balance



MATERIALS

- Soda straw
- Pin
- Two jar lids
- Standardized mass units

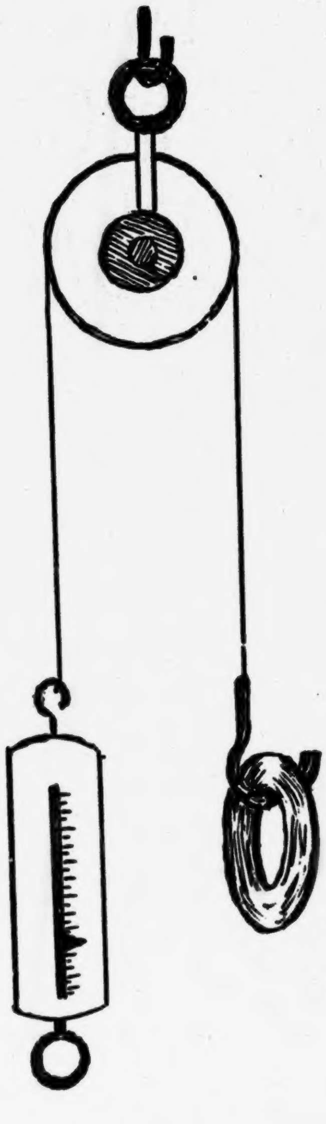
INVESTIGATION

The soda straw balance is a rather special case of the ruler balance principle applied to a measuring device. The drawing and model provided by the teacher should serve adequately for the construction phase. The student should experiment with mass determinations of various objects using standards of known relative mass. The standards should be developed by the students beginning with a base unit made from paper punches.

HISTORY

This balance provided students with a delicate instrument used by many to determine mass changes in small living organisms, water content of various materials and solubility of unknown powders.

Pulleys



MATERIALS

- Spring scale (range 0-250 force units)
- One pulley (single)
- String
- Washers
- Metal hook

INVESTIGATION

The investigation of applied force versus numbers of washers for a fixed pulley is a good beginning. Student discussion of the teachers display model and the drawing should be encouraged and predictions about the results may be recorded for later reference. The class should be familiar with data tables and recording. The second activity will be to decide on other ways of lifting objects with one single pulley. How do these compare to the first system?

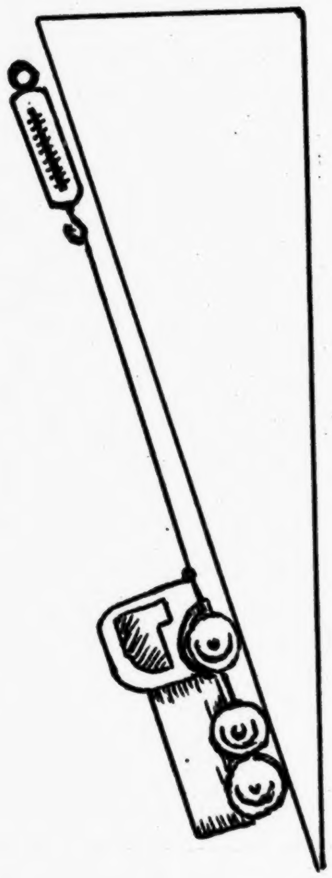
ASSIMILATION

The results should be recorded and examined critically for a mathematical pattern which would allow us to predict the behavior of other pulley systems. The pattern is generally not obvious and will probably require time for thought.

HISTORY

The pulley is one of man's oldest simple machines, yet from this activity it is apparent that many textbooks and potential science students are misinformed. Students continue this activity with investigations of pulley combinations, multiple pulleys, and a re-evaluation of the ruler balance.

Inclined Plane



MATERIALS

- Spring scales (various force maximums)
- Cart or truck
- String
- Washers

INVESTIGATION

The minimum investigation of the inclined plane will include a comparison of force distance and height lifted. The investigator is faced with the same type of analysis and data collection as performed in previous inquiries. The relationships are not so obvious, and results might be corrected for variations not considered. The investigator is confronted with the initial problem, and a model of the beginning apparatus is set up by the teacher. Generally, it will be necessary for pupils to work as a team of two since considerable manipulation is required.

ASSIMILATION

After the investigating teams have collected and studied their data, a group discussion including suggestions for modifications and verifications of theories is in order. The problem of technique and measurement will need to be agreed upon by the group if they wish to pool their data.

HISTORY

The inclined plane involves the basic concepts of the preceding investigations plus techniques of a somewhat more complex nature. The past history indicates that intermediate grade-level children can quantitatively handle this particular inquiry. The discovery of inertia is of particular interest since it is generally not discovered previous to this activity. The problem of advantage and the physical significance of work have always been important outcomes of this activity.

APPENDIX B

ATTITUDES TOWARD ELEMENTARY SCHOOL SCIENCE

HOW DO I FEEL ABOUT TEACHING SCIENCE?

SUMMARY OF STUDENT TEACHING BEHAVIORS IN SCIENCE

ATTITUDES TOWARD ELEMENTARY SCHOOL SCIENCE

Leaders in science education stress the importance of concepts, generalizations, scientific methods, and attitudes. While progress has been made in most of these areas, much more work must be directed toward the development of positive attitudes toward science. The term "attitude" used in this questionnaire refers to how an individual feels about elementary school science--an emotionalized feeling for or against science. (A distinction needs to be made between this type of attitude and the term scientific attitude or scientifically minded person who possesses an open-mind, looks at a problem from many sides, and seeks reliable sources for his evidence.)

This questionnaire is designed to measure how you feel about elementary school science. Most of these statements were obtained by asking 200 prospective elementary school teachers to write short statements of their feelings about science. Please indicate your feelings by circling the number which indicates the degree with which you agree or disagree with each statement. Remember that these statements were made by students like yourself and you should interpret them from the point of view of a prospective elementary school teacher and your own feelings and experiences.

EXAMPLE: Democrats are interesting people.

AGREE----1----2----3----4----[✓ 5]----6----7----8----9----DISAGREE

Note that 5 is circled, indicating neither strong disagreement nor strong agreement.

COMPLETE THE FOLLOWING STATEMENTS IN A SIMILAR MANNER:

1. "Field trips to such places as botanical gardens or observatories make science an interesting subject."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

2. "Science is unrelated to life experiences."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

3. "I wish I had been given more science instruction in elementary school."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

4. "I never could see anything through a microscope."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

5. "It is very helpful to know the basic facts about animal life."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

6. "Science seems to be 'over my head.'"

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

7. "Possibilities for student participation make science an interesting subject."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

8. "The study of science doesn't bore me, but I would never pursue it independently."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

9. "It is fascinating to study live specimens in the classroom."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

10. "I am always interested in learning more about science."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

11. "I just hate mice, worms, bugs, and any other small, crawling thing."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

12. "Science education is a 'must' at this time."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

13. "Scientists are people who invent something to improve everyday living."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

14. "Science learnings are often the basis of a good hobby."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

15. "Science is very important in this scientific age in which we live."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

16. "A lizard is an interesting and attractive classroom pet."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

17. "Science is interesting, but not as important as other subjects."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

18. "Science is boring."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

19. "I like to do science experiments."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

20. "Elementary school science should be taught to groups of children with approximately the same I.Q."

AGREE----1----2----3----4----5----6----7----8----9----DISAGREE

HOW DO I FEEL ABOUT TEACHING SCIENCE?

It seems to be generally agreed that most prospective elementary school teachers feel less confident about the teaching of science than they do about teaching the "three R's." Part of this may be the result of the less adequate preparation of the teacher in science; part may come from the feeling of the teacher himself that he is inadequately prepared to teach science.

This questionnaire is designed to measure how confident you may feel in various situations involving several aspects of elementary science teaching. Please indicate your feelings with respect to the situations on the following pages by circling the appropriate number before each item on the answer sheet. For example, if you have "very high confidence" about a certain situation, circle the number 5; if you have "moderately high confidence" circle the number 4; and so on, utilizing the code shown below:

(5) Very high confidence
(4) Moderately high confidence
(3) Uncertain
(2) Moderately low confidence
(1) Very low confidence

SITUATION A

Your class is doing a unit on "Animals." The children ask the question, "How are plants and animals alike?" Below are some possible activities which you and the class may do. How confident would you feel about each?

1. Have children observe pets and plants at home to see how they are similar in basic needs.
2. Take the class on a field trip to notice the variations in plants and animals.
3. Do experiments to see if both plants and animals need water, food, etc.
4. Discuss with the class some of the similarities and differences between plants and animals.
5. Provide reference lists of children's books on plants and animals.

SITUATION B

A fourth-grade teacher is just a little afraid to do experimentation with her class. One day she attempted to demonstrate the presence of carbon dioxide in the breath. She had one of the pupils blow air through a straw which was immersed in a glass of lime water. The carbon dioxide in the pupil's breath should have made the calcium precipitate out and turn the water a milky color. However, much to the class's delight, the lime water stayed clear and the calcium did not precipitate. Below are some possible activities which could be undertaken. How confident would you feel about each?

6. Do the experiment over again using a new solution of lime water.
7. Discuss suggestions from the class to determine what was the reason for the failure in the experiment.
8. Try another experiment which will show the same body process as the one which failed.

9. Discuss some other related experiments which attempt to show the same results as the one which failed.

10. Encourage reading by children to discover possible reasons for failure in the experiment; provide reference materials for them to use.

SITUATION C

Your class is working on a unit study in "How do plants grow?" Below are some possible activities which may be carried out by the children and the teacher. How confident would you feel about each?

11. Read in books about plants and how they grow.

12. Observe a plant in a box or container to record growth changes.

13. Do experiments to show how a plant seed germinates.

14. Provide a list of references of children's books.

15. Have a sharing discussion about plants that children have in their homes.

SITUATION D

Your fourth grade class is studying a unit on weather. The question is raised, "How does the weather man know it's going to rain?" In looking at these possible activities, how confident would you feel about each?

16. Construct and use a model barometer or other equipment used by the weather man.

17. Use science kit to conduct experiments to determine causes of precipitation, condensation, etc.

18. Encourage children to read in reference material to find information about weather (books, magazines, weather reports, etc.)

19. Help the children design and follow through with a daily weather chart.

20. Form a committee to investigate the question further and provide a list of resource materials for committee use.

SITUATION E

Your class is doing a unit study in "How simple machines help us." Below are some possible activities which may be carried out by the children and the teacher. How confident would you feel about each?

21. Observe the ways that simple machines are used in the school or community and record results of observations.

22. Provide a list of children's books on the uses of simple machines.

23. Discuss with the class the basic principles behind the workings of a pulley and some of its practical uses.

24. Have a sharing and discussion period about children's toys which resemble simple machines.

25. Discuss some of the uses of similar simple machines such as the lever, inclined plane, ball bearings, etc.

SITUATION F

While on a field trip, the school bus passes through an area where corn is planted. It has been a rainy year, and some of the corn fields are flooded in spots, and the corn is dying. The children, discussing the trip the next day, raise the question, "We have always been told that water is needed for plant life; why is the corn dying? It has plenty of water." In terms of the activities, how confident would you feel about each?

26. Discuss some experiments which the class may do to determine some of the requirements of plant life, and some conditions which may harm plants.

27. Do experiments with different kinds of plants (corn, watercress, wheat, bean, etc.) to show that each of them have slightly or greatly different environmental requirements for ideal growth.

28. Form a committee for further investigation of the problem; provide appropriate reference materials for them to use.

29. Have children observe plants in their homes and gardens to determine effects of the environment on the plants.

30. Make an observational chart of some local plants which live in the water, others which live on dry land. Observe local plants and record results.

SITUATION G

Your classroom is doing a unit study on the solar system. Below are some possible teacher-pupil activities. How confident would you feel about each?

31. Plan a trip to a nearby observatory or planetarium.

32. Find information about the solar system in materials other than the text which would be at an appropriate reading level for the children.

33. Design an observation chart of the visible planets. Observe the visible planets and keep a record of their positions in the night sky.

34. Construct a model of the solar system using balls, marbles, or beads to show the approximate relative sizes of the sun and the planets.

35. Have a class discussion on the importance of the sun.

SITUATION H

Your classroom is working on a unit study of "Electricity and what it can do." Below are some possible activities which may be carried out by the children and the teacher. How confident would you feel about each?

36. Construct a model electric motor from inexpensive materials.

37. Do experiments to show how a light bulb works.

38. Dismantle old or broken appliances to observe and learn more about how they work.

39. Provide a list of references of children's books on the uses of electricity.

40. Discuss some of the ways electricity is used in the school.

SUMMARY OF STUDENT TEACHING BEHAVIORS IN SCIENCE

DIRECTIONS: Please summarize the teaching behaviors in science of the student teacher under your supervision by completing the following items. If explanations are necessary, please write your comments under the appropriate item.

(1) If the student teacher did not teach science, please check here ______and check the appropriate reason. (Not necessary to complete items 2-16.)
   ( ) Science is not taught in this grade. Grade_____.
   ( ) Science is taught as a special subject and she did not have the opportunity to teach in this area.
   ( ) Plans for the semester were already finalized and did not include science.
   ( ) Science units had already been completed before her student teaching period.
   ( ) Other. Describe:______________________________.

(2) If the student teacher did teach science during the last four weeks of the student teaching period, what was the average time per week spent on science? _____0-59; _____60-119; _____120-179; _____180-239 minutes per week.

DIRECTIONS: For the following items, circle the number on the scale to indicate the degree of the student teacher's confidence in teaching science (number 5 indicates a "so-so" or uncertain position); OR indicate why you are unable to judge this item (example: student did not perform this type of activity).

(3) How confident was she about finding information about a particular science subject in materials other than the text or manual which would be at an appropriate reading level for the children?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________.

(4) How confident was she about leading a discussion-and-sharing period on the basic principles behind a particular science concept or a particular experiment or demonstration?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________.

(5) How confident was she about designing observation exercises such as observing and recording plant growth, observing ways in which simple machines are used in the school, observing the effects of environment on animals, etc.?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________.

(6) How confident was she about conducting experiments or demonstrations to test hypotheses (find out things) or helping children design and set up experiments or demonstrations?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________________.

(7) How confident was she about encouraging reading by children to investigate a question further and providing a list of reference materials?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________________.

(8) How confident was she about leading a discussion-and-sharing period on the materials in the science textbook?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________________.

(9) How confident was she about planning and organizing a field trip to observe "science in action?"

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________________.

(10) How confident was she about constructing and using simple models or other science apparatus, or manipulating simple tools?

High confidence --9 --8 --7 --6 --5 --4 --3 --2 --1 --Low confidence
Unable to judge because:______________________________________.

DIRECTIONS: For the following items, circle the number on the scale to indicate the degree of the student teacher's feelings toward science (number 5 indicates a "so-so" or uncertain position); OR indicate why you are unable to judge this item (example: student did not exhibit this type of feeling).

(11) Did she exhibit the attitude that science is very important in this scientific age in which we live?

Yes ---9 ---8 ---7 ---6 ---5 ---4 ---3 ---2 ---1 ---No
Unable to judge because:______________________________________.

(12) Did she exhibit the attitude that science seems to be "over her head?"

Yes ---9 ---8 ---7 ---6 ---5 ---4 ---3 ---2 ---1 ---No
Unable to judge because:______________________________________.

(13) Did she exhibit the attitude that possibilities for student participation make science an interesting subject?

Yes ---9 ---8 ---7 ---6 ---5 ---4 ---3 ---2 ---1 ---No
Unable to judge because:____________________________________.

(14) Did she exhibit the attitude of "I just hate mice, worms, bugs, and other small, crawling things?"

Yes ---9 ---8 ---7 ---6 ---5 ---4 ---3 ---2 ---1 ---No
Unable to judge because:____________________________________.

(15) Did she exhibit the attitude that lizards, hamsters, fishes, etc. are interesting and attractive classroom pets?

Yes ---9 ---8 ---7 ---6 ---5 ---4 ---3 ---2 ---1 ---No
Unable to judge because:____________________________________.

(16) Did she exhibit the attitude that science is unrelated to life experiences?

Yes ---9 ---8 ---7 ---6 ---5 ---4 ---3 ---2 ---1 ---No
Unable to judge because:____________________________________.

VITA

Eugene Akio Oshima

Candidate for the Degree of

Doctor of Education

Thesis: CHANGES IN ATTITUDES TOWARD SCIENCE AND CONFIDENCE IN TEACHING SCIENCE OF PROSPECTIVE ELEMENTARY TEACHERS

Major Field: Higher Education

Biographical:

Personal Data: Born in Kaneohe, Hawaii, January 2, 1934, the son of Toyotoshi and Hisayo Oshima.

Education: Attended the University of Hawaii in 1952; received the Bachelor of Arts degree from Colorado State College, with a major in biological science and minors in physical science and mathematics, in 1955; received the Master of Arts degree from Colorado State College, with a major in biological science, in 1956; attended summer session, Colorado State College, in 1958; awarded National Science Foundation Summer Chemistry Institute, Colorado State College, in 1960; awarded National Science Foundation Biology Institute, Southern Illinois University, in 1962; awarded National Science Foundation Sequential Summer Institute, Kansas State Teachers College, in 1963; awarded National Science Foundation Academic Year Institute, Oklahoma State University, in 1964; completed requirements for the Doctor of Education degree in July, 1966.

Professional Experience: Appointed graduate teaching assistant, Colorado State College, in January, 1955; science teacher and Head of Science Department, Oberlin, Kansas, 1956-1964; science consultant, Summer Enrichment Program, Stillwater, Oklahoma, in 1965; appointed graduate teaching assistant, Oklahoma State University, in September, 1965; science consultant, summer session, East Central State College, in 1966; science consultant, summer session, Oklahoma State University, in 1966.

Professional and Honorary Organizations: Graduate member, Lambda Sigma Tau; life member, Phi Delta Kappa; member, Oklahoma Academy of Science; member, National Science Teachers Association.